THE MAGAZINE OF FLUID POWER

Hydraulics & Pneumatics

OCTOBER 1961

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NATIONAL CONFERENCE ON INDUSTRIAL HYDRAULICS

Special Report Featuring Program and Abstracts

PRIZE PAPER CONTEST AWARDS 1961

1. Interlocking Air Circuits for Reliable Sequencing
2. Techniques for Designing Airborne Components
3. Closed Circuit System Powers Tractor's Hydraulics

AN INDUSTRIAL PUBLISHING CORPORATION MAGAZINE

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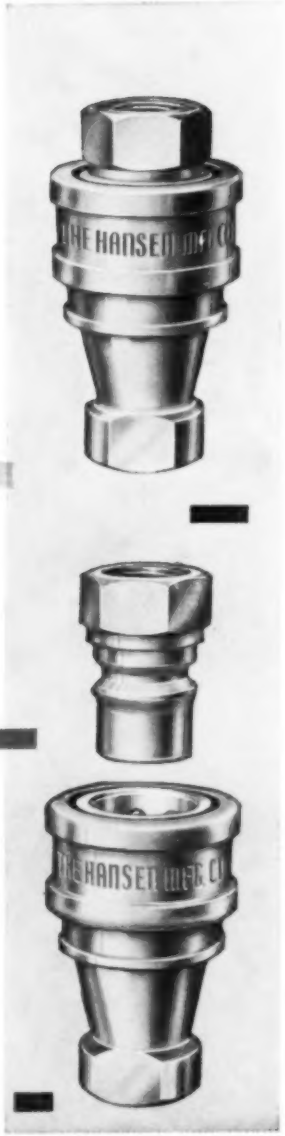

QUICK FLUID LINE CONNECTION OR DISCONNECTION

WITH

INSTANT AUTOMATIC FLOW OR SHUT-OFF

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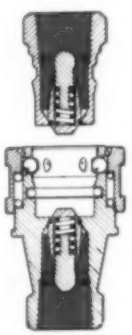

When Coupling is disconnected, identical valves in both the Socket and Plug provide instant shut-off of gas or liquid. To eliminate leakage or spillage during disconnection, the Coupling is so designed that shut-off takes place *before* the Plug separates from the Socket—and *before* the seal of the Socket itself, provided by the Socket "O" Ring, is broken.

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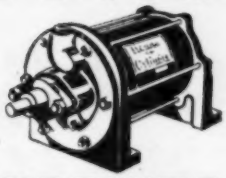
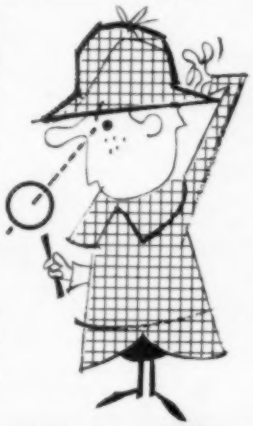
THE "OLDEST" HANNA CYLINDER



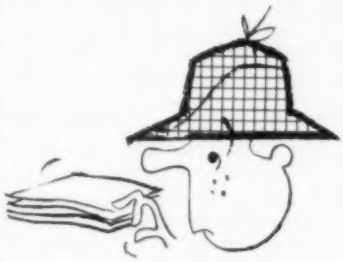
Hundreds of Hanna air and hydraulic cylinders built years ago are still in use. This year Hanna Engineering Works celebrates its 60th year as a manufacturer of air and hydraulic equipment. *You* can win a reward by finding one of the oldest, operating Hanna cylinders.

WHERE TO LOOK



Perhaps the oldest Hanna cylinder has seen service on several jobs around your plant. Frequently, when one job is finished, a Hanna cylinder will be moved to another job, because the cylinder still works as good as new. The oldest Hanna cylinder is typical of all Hanna cylinders built since—tough, sturdy, long lasting, built to take it.

WARNING:



Don't look for the oldest Hanna cylinder on your maintenance records, or among purchase orders or requisitions for replacement parts. This Hanna cylinder might be buried or almost forgotten, simply because it has done its job so well for so long that it is taken for granted. Even parts that are normally replaced, like piston and rod packings, may not show up on your records because of Hanna's pioneering in the use of rod packings that compensate for wear and "sealed for life" automotive type piston rings.

FINGERPRINTS

Every Hanna cylinder built has been fingerprinted—its serial number has been entered on a permanent Hanna record. Its age, dimensions, mounting and construction details are on file. That's why replacement parts, if ever required, can be furnished exactly as needed. No slip-ups or costly delays when ordering parts for a Hanna cylinder.

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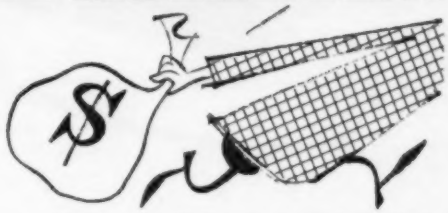

If you have an old Hanna cylinder in your shop, fill in the coupon and mail it to Hanna Engineering Works. We will send you an official entry blank which qualifies you for one of three, one hundred dollar prizes for the person identifying the first, second or third oldest Hanna cylinder. The companies in which the three oldest Hanna cylinders are found will receive, for their next cylinder requirement, one new standard Hanna Powrmation or Powrdraulic air or hydraulic cylinder of any size up to eight inch bore. Mounting and stroke may be selected from the Hanna catalog.

Contest closes November 30, 1961. All entries must be postmarked before midnight of that date. Contest open to residents of United States of America only.

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Employed by_____

Address_____

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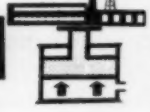

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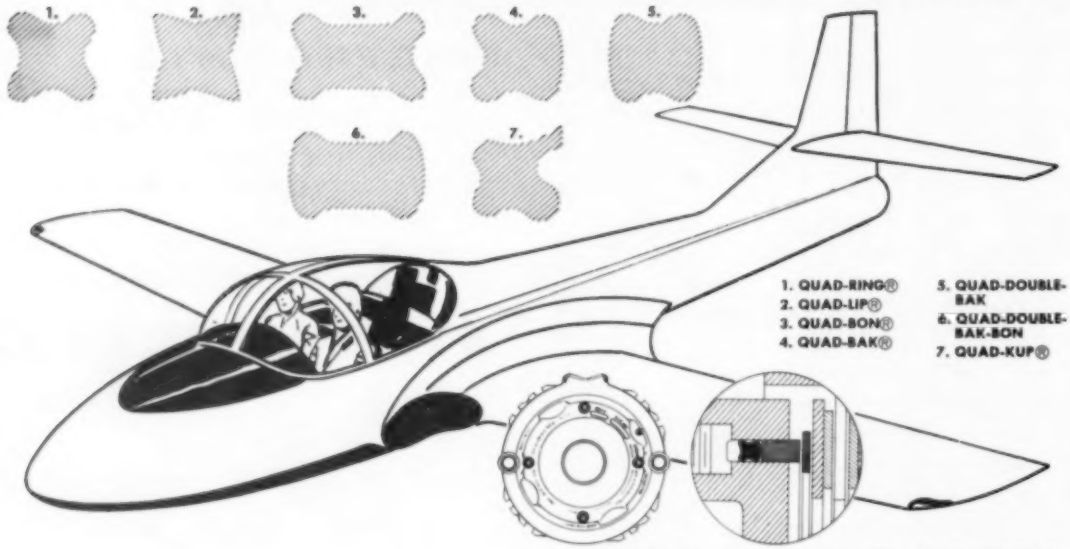

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QUAD-BON—Provides maximum resistance to spiraling in the smallest space possible while maintaining the sealing characteristics of the basic QUAD-RING.

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VOLUME 14/NUMBER 10

OCTOBER 1961

THE MAGAZINE OF FLUID POWER

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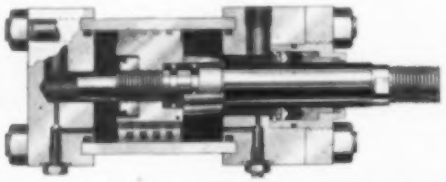

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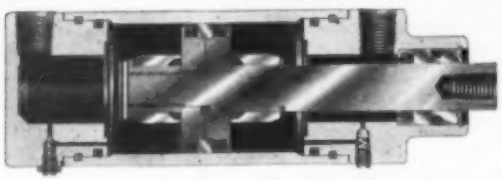

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- New design opportunities
- To 370° rotation as standard
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Out-of-print copies of HYDRAULICS & PNEUMATICS Magazine are available in complete volumes as positive microfilm copies from: University Microfilms, 313 N. First Street, Ann Arbor, Michigan.

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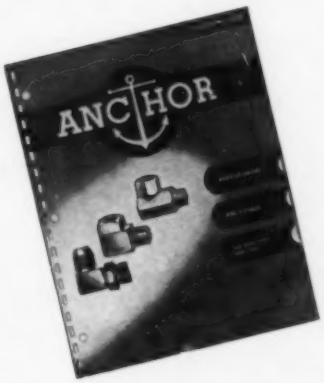

This recently issued catalog is a revision of an earlier catalog describing Anchor's line of hydraulic fittings, unions and adapters, and now includes many new sizes and a general expansion of the line. It contains complete specifications, illustrations and drawings, including full information about the new items, plus other data and engineering information that will prove helpful to the engineer in designing fluid power transmission systems.

The Anchor line of Adapter Unions, Tees and Crosses is designed for use with Anchor Pressed-On or Reusable Coupling Hose Assemblies. They form a ground joint, leak-proof connection and eliminate one or more pipe thread joints at each connection. Assembly is made easier, especially in confined areas. Straining and twisting of hose in assembly is eliminated.

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Copies of the new Catalog No. 206 may be obtained by writing Anchor Coupling Co. Inc., 363 No. Fourth St., Libertyville, Illinois.

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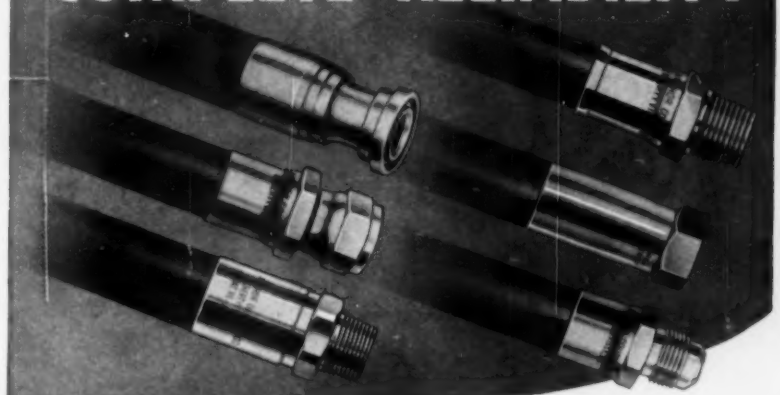

Anchor Pressed-On Hydraulic Hose Assemblies are demonstrating their *complete reliability* — as they have for over 20 years — on all fluid power equipment . . . contributing substantial savings in original and replacement costs . . . reduced maintenance . . . longer life . . . and uninterrupted service.

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SYRACUSE 1, N. Y.
Ralph W. Earl Co., Inc.
HOward 3-9244

TULSA, OKLA.
Nix Supply Co.
Diamond 3-8916

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Cowper Co., Ltd.
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Fluid power problem?...

Your local Norgren representative can help

Norgren representatives are fully-qualified fluid power specialists—top flight men in this field.

They will be glad to give you expert technical information and assistance in any phase of fluid power: filtration . . . valving . . . lubrication . . . regulation . . . using fluid power for automatic control. They will counsel with you as to the best means of adapting pneumatic controls to a machine or machine mechanism.

Your local Norgren representative handles a complete line of fluid power components. Call him for expert application help, for quick delivery of parts and for the best of service. He is a good man to know.

For complete technical information about Norgren Pneumatic Products—Pressure Regulators, Compressed-Air-Line Filters, Oil-Fog and Micro-Fog Lubricators, Control Valves—ask your Norgren representative (listed at left) for catalog N. 1000 . . . or write factory.

FOUNDED IN 1925

C. A. NORGREN CO.

3402 SOUTH ELATI STREET • ENGLEWOOD, COLORADO

Fluid Power news

OILGEAR 40 Years of Fluid Power

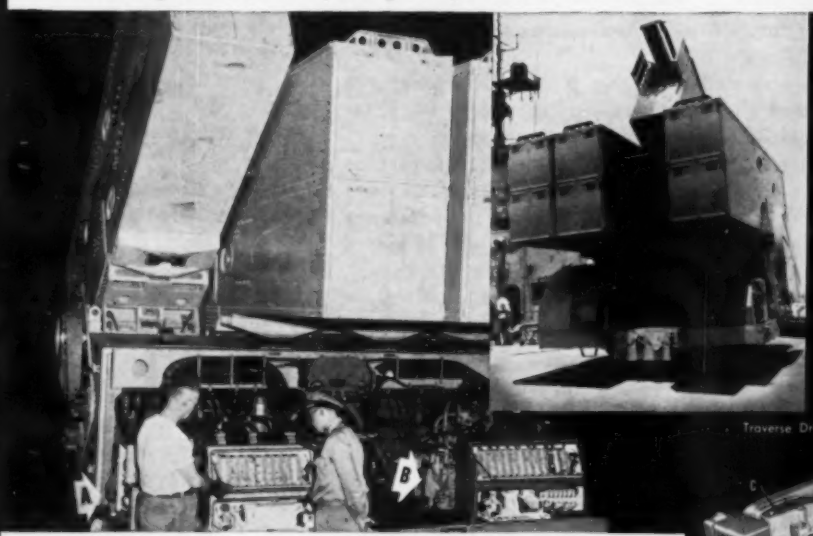
Report No. 11,400 From Oilgear *Application-Engineering* Files

HOW OILGEAR ELECTROHYDRAULIC SERVO-VALVE-CONTROLLED DRIVES AIM *ASROC** MISSILE LAUNCHERS IN RESPONSE TO LOW-POWER SIGNALS FROM SHIPBOARD DIGITAL COMPUTERS.

**ASROC (Anti-Submarine ROCket) — the Navy's deadliest, integrated, anti-submarine weapons system — consists of 4 major parts: an underwater sonar detection device; an electronic, digital, firecontrol (aiming) computer; a "pepper-box" type, 8-missile launcher; and ASROC missiles. Within seconds after sonar detection of a hostile submarine, the computer charts its course, speed, and range — correlated with the ASROC-equipped ship's course, speed, and roll. The resultant computer signals command the launcher to traverse and elevate instantly to accurate "aim" position, and continue to "track" from subsequent computer command signals. The ship commander merely pushes a button to fire either rocket-propelled, homing torpedos or depth charges.*

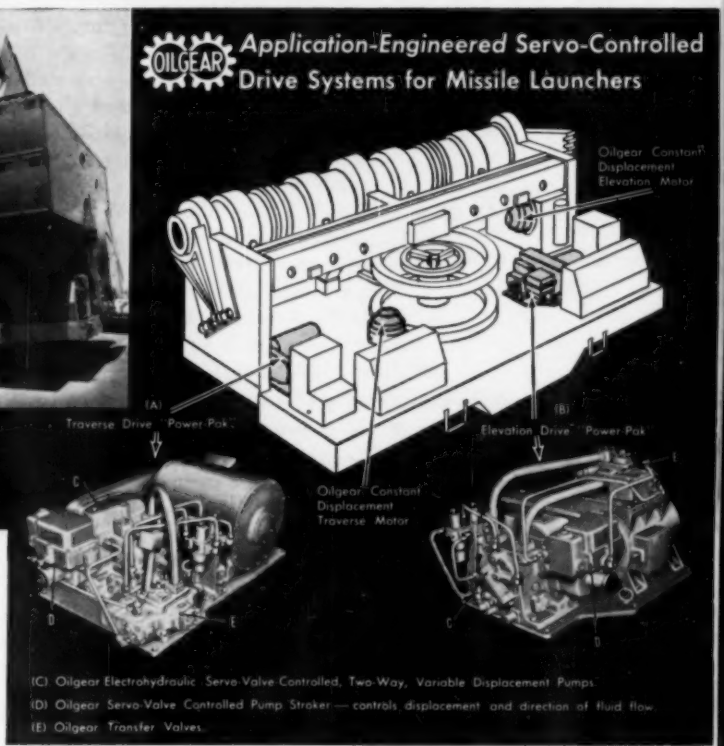
PROBLEM: Power and control for both the traverse and elevation drive systems to "aim" ASROC missile launchers in response to direct, low-power, electrical command signals from a digital firecontrol computer.

REQUIREMENTS: 1. High traverse and elevation speeds in either direction, with shockless reversal, to bring launcher "on target" — rapidly. 2. Fast, accurate control response for high-speed "homing." 3. Precisely controlled, low variable speeds for "tracking." 4. Entire drive and control systems to occupy a minimum of space within the launcher base. 5. Dependability — "no time-out permitted" — a rigid requirement for fleet use. 6. Unitized assemblies preferred, to facilitate installation and replacement.



Official Photos — U.S. Navy. Actual launcher performance data is classified information.

ABOVE: ASROC missile launcher being checked at U.S. Naval Ordnance Plant, York, Pennsylvania. Arrows indicate traverse (A) and elevation (B) Power-Paks. **INSET:** ASROC launcher ready to fire aboard U.S.S. Norfolk. Each of the 8 cells serve as missile stowage magazines and launchers — all traverse as a unit . . . each over/under pair of cells elevate individually. 360° launcher traverse is possible, but a quadrant is blocked to protect ship's superstructure. Missiles weigh about 1,000 lbs., are about 15 ft long. Launcher base sketch, right, approximates position of Oilgear Drives.



(C) Oilgear Electrohydraulic Servo-Valve Controlled, Two-Way, Variable Displacement Pumps.
(D) Oilgear Servo-Valve Controlled Pump Stroker — controls displacement and direction of fluid flow.
(E) Oilgear Transfer Valves.

SOLUTION: With Oilgear's experience in meeting the speed, control, and precise turret and gun performance requirements for U.S. Army tanks, howitzers, and anti-aircraft guns — this missile launcher application was a "natural" for Oilgear *ANY-SPEED* Drives — and the alert, accurate response of Oilgear's Electrohydraulic Servo-Valve-Controlled, Two-Way, Variable Displacement Pumps. Amplified signals up to 5-watts actuate drive controls. Cushioned, full-speed drive reversal. These small, rugged, Oilgear *ANY-SPEED* Pump and Motor Drives easily convert output from constant speed electric motors into the exact, required traverse and elevation speeds, direction, and torque . . . even under high overload conditions. An automatic feedback control compensates for load, voltage, or viscosity changes to accurately maintain computer-selected speeds. Torque transmitted automatically increases or decreases to a point just sufficient to overcome resistance. There's no "wire-drawing," or bypassing of fluid to generate heat or waste power. Both systems are totally enclosed, automatically protected against overload, pressure and flood lubricated to assure long, dependable, maintenance-free, service life.

Oilgear engineering and equipment has solved innumerable "problem drives." Users of Oilgear *ANY-SPEED* Drive and Control Systems in the paper, marine, food, chemical, pharmaceutical, primary metals, metalworking, textile, rubber, and other industries — as well as the military . . . agree that — *"for the lowest-cost-per-year . . . it's OILGEAR!*

For practical solutions to YOUR rotary or linear drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

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FLUID POWER LINES

from editor to reader

THE FUTURE FOR JIC

Since their beginning in 1947, sponsorship of JIC Standards has been the responsibility of the major automotive manufacturers. The Standards began with a committee of GM divisional plant managers which was formed to study the problem of high maintenance of hydraulic equipment. Even minor repairs were causing long periods of downtime and production delays.

After several meetings, it was recognized that the problems were not only those of GM but involved all of industry. So other large users, including other automotive companies, were invited to cooperate.

After a number of meetings where manufacturers' associations such as National Machine Tool Builders, Hydraulic Press Manufacturers, and Resistance Welder Manufacturers were represented, the first Joint Industry Conference Hydraulic Standards for Industrial Equipment were approved in September 1948. Pneumatic Standards were completed in 1950.

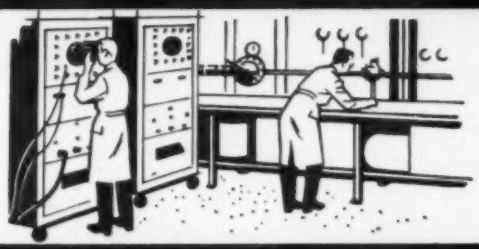
Last November, one large automotive company decided not to participate further in the conferences and to publish individual company standards instead. The hazards of this situation should be apparent to all those in the fluid power industry: component manufacturers, machine builders, and users alike. Inconsistencies among various standards could work hardships on those who seek lower costs through high production of standard equipment.

To maintain unified standards which represent the combined efforts of all phases of the fluid power industry, the National Fluid Power Association has begun negotiations with the automotive companies to act as new sponsor for the standards. Initial response has indicated a willingness to cooperate with the Association. It is the aim of NFPA, which is made up of companies manufacturing hydraulic and pneumatic components, to coordinate activities of all organizations and companies concerned with fluid power standards, and to arrange for conferences in which these groups can come together.

We believe that this fresh effort will bring a renewed interest in the standards which have been so valuable in promoting better equipment: improved circuit design through the use of meaningful symbols . . . less leakage with subplate and panel mounting . . . and better access, filtering, cooling, and deaeration through good reservoir design. We look forward to even more useful standards having the endorsement of the ASA, and to cooperation of our American group with international organizations concerned with unified standards among foreign countries.

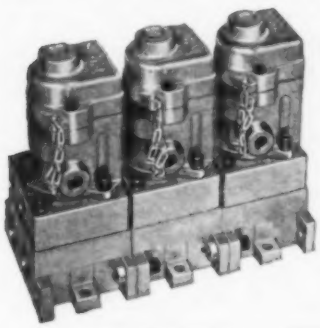
Allan E. Morris

Editor



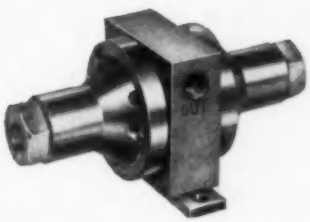
Out of the **Ross** research lab has passed the most extensive line of valves in the air control world

4 fine valves from the Ross valve line



Fast valves manifolded

The PACER 4-way gives 1000 cpm and more, has all JIC features, is built for super long life. Manifold as many as you please. One air supply, one exhaust.

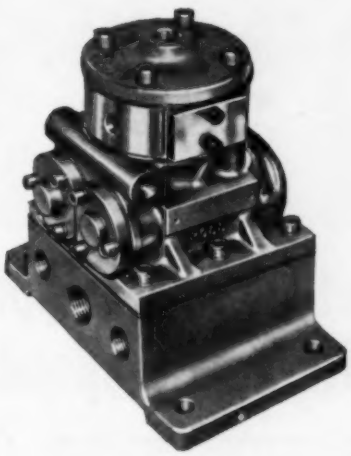


For greater press safety

The Non-Tie-Down valve is designed to protect the press operator's hands. Requires the operator to activate two separate valves continuously during a machine's cycle.

Overriding cam operation

The PCB valve—A ¼" valve with low minimum operating pressure—5 psi to 125 psi—that is fast operating and ruggedly built. Overriding cam activates valve from one direction only.



Air operation with momentary action on a 4-way, 5-port

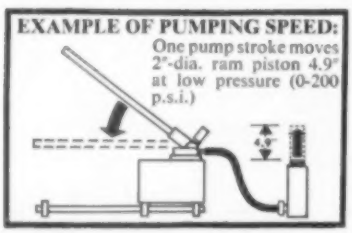
Need to send a cylinder home hard but return it softly . . . or vice versa? This 4-way, 5-port lets you supply two different pressures to the cylinder. And the air index adaptor gives you momentary action. The main valve reverses and stays put with each air impulse delivered to the air operated head.

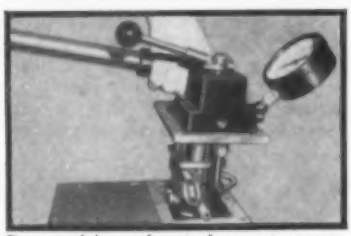
For more information write us, or contact your nearby Ross representative. See our digest catalog in Sweet's

THE WORLD'S MOST COMPLETE LINE OF AIR CONTROL VALVES. AVAILABLE ALL OVER THE FREE WORLD.

Ross OPERATING VALVE COMPANY
105 E. GOLDEN GATE • DETROIT, MICHIGAN

Get fast ram approach, save time with new 2-speed hydraulic pump





Pump, valving and controls mount on common cover plate; use with other reservoirs.

- **Delivers a big 7.35 cu. in. of oil per stroke at low pressure (0 to 200 p.s.i.)**
- **Delivers .294 cu. in./stroke from 200 to 10,000 p.s.i. for high force requirements**
- **For operating both single and double-acting cylinders**

Here is a compact, precision-built 10,000 p.s.i. 2-speed hand pump with the ability to deliver exceptionally high volume at low pressure for fast ram approach and return. Handle high-force requirements, yet waste no time getting the ram to the work! Choice of 2-way or 4-way control valve, mounted easily on cover plate; no exposed piping. Unit weighs only 34 lbs.

Ask your OTC distributor about the new OTC "Dual-master" pump.

PRECISION HYDRAULICS DIVISION

OWATONNA TOOL CO.

710 CEDAR ST., OWATONNA, MINN. CABLE: TOOLCO

RESEARCH · ENGINEERING · DEVELOPMENT

OTC

DESIGNERS AND MANUFACTURERS OF QUALITY HIGH PRESSURE HYDRAULIC COMPONENTS

Circle **110** on Reader Service Card

LETTERS to the editor

Fluid power course outlines

TO THE EDITOR:

We were very interested in your mention of outlines for courses in fluid power.

Lately we have been facing the problem of course organization while training our staff. We would appreciate it very much if you would mail us the outlines.

D. FINDER
Mifaley Romema, Ltd.
Jerusalem, Israel

TO THE EDITOR:

Your recent published letter concerning course outlines for fluid power subjects has stimulated our interest in the material. Can you send us copies?

J. C. FLETCHER
Course Development—Service Training
Euclid Div., General Motors Corp.
Hudson, Ohio

TO THE EDITOR:

In the May issue you mentioned sending outlines of two courses in hydraulics which were given in Cleveland. Would it be possible for us to receive the same material since we are knee deep in teaching a course in hydraulic theory and design to a group from our engineering department?

W. M. OWEN
Assistant Chief Engineer
Caterpillar Tractor Co.
Peoria, Illinois

Copies of the outlines for courses on components and circuits have been sent. We are pleased to make these available for training purposes.

Low speed, high torque motor

TO THE EDITOR:

Can you refer us to a source of supply for low speed, extreme torque, oil hydraulic motors?

We are looking for something to produce 200 hp at 30 rpm. We would prefer to work with an oil pressure of approximately 3000

Continued on page 14

NYLON PRESSURE TUBING

for Hydraulic-Pneumatic Service

On one design after another, Garlock Nylon Pressure Tubing proves superior to other materials. One specific instance concerned a hydraulically-controlled wheel dresser. The hose lines draped over the multiple-head grinders and fouled the controls. This not only impeded operation, but looked bad from an appearance standpoint. Nylon Pressure Tubing was applied. As a result, tubing cost was reduced by 70%, and installation time was cut to a minimum. Because of the self-supporting feature of the tubing, "draping" of the line was eliminated; this made operation safer, improved overall design of the wheel dresser.

In cost, too, Garlock Nylon Pressure Tubing has the advantage. Seamless copper and extruded aluminum is approximately four times as much, while welded and seamless stainless steel costs 29 to 37 times more, respectively. Also, the cost of couplings and installation labor should be considered—Nylon Pressure Tubing needs no intermediate couplings or fittings . . . is simple to install. You save on first cost, fittings, and labor.

An outstanding design material. Garlock Nylon Pressure Tubing is unaffected by oils, alkalies, hydraulic fluids and solvents that corrode metals . . . resists vibrational fatigue, abrasion, impact . . . withstands temperatures from −60°F to +300°F . . . available in 1000 and 2500 p.s.i. burst ratings, conforming to J.I.C. specifications. Diameters from 1/8" O.D. to largest size commercially made.

For more data, call your representative at the nearest of the 26 Garlock sales offices and warehouses throughout the U.S. and Canada. Or, write for Catalog AD-177. Garlock Inc., Palmyra, N.Y.

Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Company

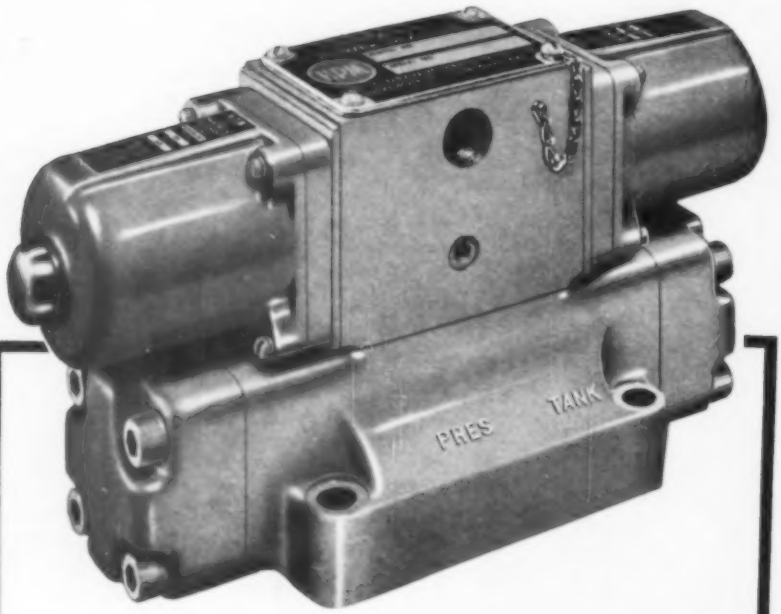
Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

Garlock Nylon Pressure Tubing can be twisted, flexed, bent . . . ideal for hydraulic-pneumatic systems, pressure lubrication lines, oil and fuel lines, vacuum connections.

GARLOCK

INTERCHANGEABLE

H-P-M ¾" and 1¼" 4-way valves



These solenoid operated, pilot controlled 4-way valves are designed for continuous, heavy duty 3000 psi service. They feature oil immersed solenoids as standard to lessen shock and wear on both solenoids and valve parts. They are completely interchangeable with industry standards and are available for fast delivery from stock.

These H-P-M 4-way valves offer unusually good flow characteristics. Pressure drop charts, the result of actual tests, are available. They illustrate the high efficiency of the H-P-M design. Send for your copy today. Dimensional specifications will be included.

H-P-M DIVISION
Koehring Company
Mt. Gilead, Ohio, U.S.A.

HPM

H127

Circle **60** on Reader Service Card

LETTERS

psi. We could use one of the readily available fluid motors at a higher speed, but a reducer of the necessary ratio and torque capacity is expensive and our customer would prefer to spend more on the hydraulic equipment and avoid the complication of adding the speed reducer.

E. C. DITZEN
Ditzen Engineering & Sales Co.
Oakland, Calif.

We've suggested two fluid motors which may be suitable for your use. As you know, high torque, low speed motors are in increasing demand, primarily for vehicle drives.

Tubing cleanliness

TO THE EDITOR:

A more exact meaning of the "cleanliness" paragraph in Appendix D of the JIC Standards is needed in connection with our procurement of pipe and tube for hydraulic and air service. Our service has many expensive pilot-operated valves, and cleanliness is most desirable. A cleaning procedure applicable to various sizes of pipe and tube, or explicit inspection specifications would be most helpful.

DALE E. SMELSER
Project Engineer
Rohm & Haas Co.
Philadelphia

Rubber pad press

TO THE EDITOR:

Is any data or experience available on the design or construction of presses of short stroke which are actuated by compressed air or oil against a diaphragm over a rectangular plate?

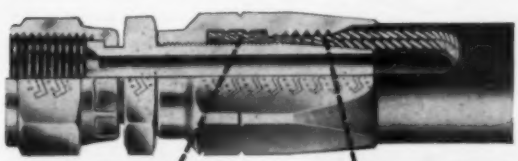
R. STONE
Remington Stone Quarries
Bishop, Calif.

We have sent you tearsheets of an article, describing a rubber pad press made by Loewy Hydropress Div. Baldwin-Lima-Hamilton Corp. Verson All-Steel Press Co. in Chicago also has designed rubber pad presses. ▼▼▼

WHAT IS YOUR BEST BUY IN REUSABLE HOSE FITTINGS?

Compare **STRATOFLEX** *with three other types for the answer!*

STRATOFLEX "SCREW-TOGETHER" TYPE



ENCLOSED PROTECTED WIRE

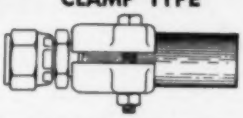
POSITIVE GRIP OF WIRE BRAID

- Minimum envelope dimension
- No special tools required for assembly or disassembly
- Uses standard hose
- Complete reusability
- Pressure rating equal to burst of hose
- Uniform compression
- Long life proven in service

SLEEVE AND SEGMENTED TYPE

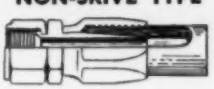
Wire exposed to corrosion • Limited reusability of segments • Large envelope dimension • Special tools and/or equipment required for assembly and disassembly • Non-uniform compression • Limited service history

CLAMP TYPE



Doesn't grip wire • Limited pressure rating • Large envelope dimension • Non-uniform compression • End of hose exposed to corrosion

NON-SKIVE TYPE



High assembly torques • Inconsistent grip of wire • Uses non-standard thin covered hose which has critical tolerances • Special tools required for proper assembly of hose to socket

SF5-1

STRATOFLEX Inc.

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For complete information, write for Stratoflex Catalog 201.

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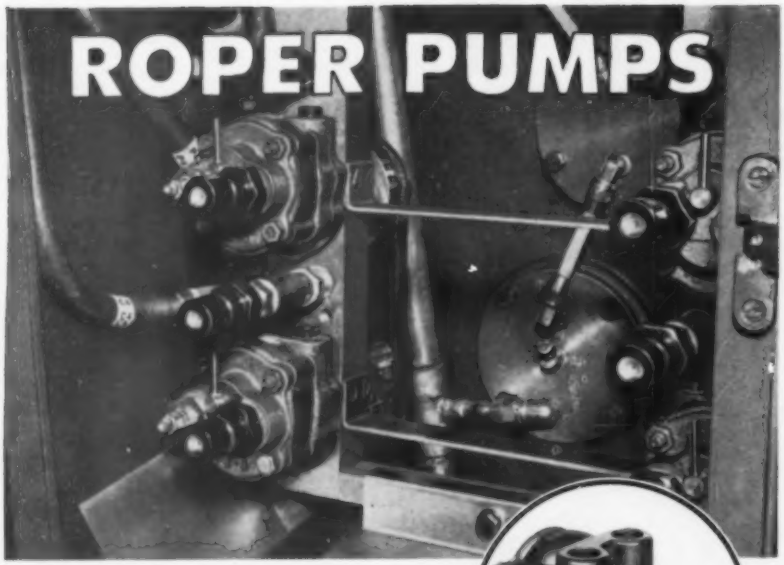

Photo courtesy R. Hoe & Co., Inc.

SERIES K FIGURE 17K3

dispense inks to individual rollers on high-speed press

• SERIES K SIZES: ¾-110 GPM • PRESSURES TO 400 PSI

This Colormatic printing press, manufactured by R. Hoe & Co., Inc., is equipped to print multi-colored inks at one press run. These inks range as high as 10,000 SSU in viscosity, and are dispensed to individual rollers at 1½ gpm under 20 psi pressure by custom-modified Roper Fig. 17K3 pumps. The four pumps on each press are manually switched into operation and are belt-driven. Valving arrangement on the pumps allows the pressman to switch from ink to solvents when cleaning the press rollers. Series K pumps are adaptable to a wide range of jobs, such as pressure lubrication, hydraulic service, fuel supply, or general transfer work. They are self-priming, and operate with equal efficiency in either direction of rotation.

Controlled Accuracy in Liquid Delivery

- One-piece, heat-treated case-hardened steel drive gear and shaft and the heat-treated driven gear run quietly in axial hydraulic balance.
- Dowel pins and shaft holes precision-bored in one machine setting for accurate manufacturing control.
- Driven gear runs quietly on stationary bearing shaft.
- Bearings are special wear-resistant bronze in standard fitted pump. All-iron units have Meehanite sleeve bearings and idler shafts.

For full information, contact your Roper dealer

Send for our new eight-page Series K catalog

ROPER HYDRAULICS, INC.

Dependable pumps since 1857
COMMERCE, GEORGIA

Circle **128** on Reader Service Card

FLUID POWER FORUM

Each month HYDRAULICS & PNEUMATICS surveys readers for their experiences and opinions in fluid power design.

• What improvements would you like to see in fluid power components?

High cycling press

We are limited by piston speeds, primarily in valving. Our immediate problem is obtaining a vibrating or reciprocating action of approximately 600 one-eighth inch movements per minute in a press developing 100 tons. Up to now we have been unable to locate a servovalve or system to do our work. This press is being built for research.

R. D. MCCOY
Sr. Research Engineer
National Seal Division
Redwood City, California

Component information

The performance of presently available components is not the limiting factor. It is *information and specifications* that are not available. Many times a design will call for a component that might be an off-shelf item, but another part, sometimes even a special or inferior part, is used because the available part was not listed in the manufacturer's catalog, or there were no specifications available on it—or there was no catalog at all.

Often the designer or engineer can not take the time to call in salesmen from several companies in order to select a small part. When time is taken to call in salesmen, too many of them are not equipped to deal with technical problems. The responsibility is not only that of component manufacturers and suppliers. Engineers and designers should make an effort to become more familiar with

Continued on page 18

NOW... Off-the-shelf delivery on 3", 6", 9", 12" and 18" stroke lengths

SERIES **SCAH**

COAXIAL AIR/HYDRAULIC CYLINDER

Series SCAH with 18" stroke length is only 28¾" long overall.

PATENT PENDING

This unique combination cylinder provides all the smoothness and precise control of hydraulic operation, yet requires only a shop air supply. Oil cylinder is concentric with the air cylinder resulting in a compact design about half the length of in-line air/hydraulic units, and far easier to install than side-by-side air/checking cylinder combinations.

It operates on air pressures from 60 psi to 200 psi, and delivers from 314# to 920# force (see table).

FORCE TABLE

Air Line Pressure psi	Extending Force #	Retracting Force #
100	460	314
120	550	375
140	645	440
160	735	500
200	920	628

FEATURES

★ Dial-set stepless load-compensated speed control in both directions assures smooth, uniform piston travel regardless of load fluctuations.

★ Oil reservoir automatically compensates for small volume changes, with visual "low oil" signal.

★ Optional built-in "skip" control for selectable rapid traverse in either direction.

★ Means of directional control include Solenoid, Pilot, Button Bleeder and other circuitry signalling means of control.

New Series SCAH Coaxial cylinders are promptly available in standard stroke lengths (special stroke lengths available on order). Standard mountings include base, front or rear flange, "L" type, rod clevis and rear clevis.

They are ideally suited for machine tool or work piece feeding, and similar applications where precise speed control, smoothness and reliability are required. Compactness of the SCAH series is especially advantageous where long stroke length, with ability to control speed throughout or at any portion of the stroke, is desirable. Call your local Modernair dealer (see yellow pages of your phone book) or write us now for literature, specifications and prices.

Modernair ® Trademark **CORPORATION**

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MEMBER NATIONAL FLUID POWER ASSOCIATION

FORUM

available components and vendors. The manufacturers should make available better catalogs that include better specifications and technical data.

Most designers and engineers are not concerned with facilities, past projects, and personnel. Yet too many component manufacturers fill their catalogs with facilities and personnel reports. They show the past projects, fantastic specials, and pictures of huge complexes which include their component. But the ever-important outline drawing or price of the component that the catalog is trying to sell is just not there. The overall problem can be helped by users letting the manufacturers know what they need in catalogs.

Another big improvement would be for manufacturers to consider it a necessity to list their products in directories such as the Fluid Power Directory. Such a directory is the best method for users to select products and vendors.

FRED MYER
Components Specialist
American Machine & Foundry Co.
Greenwich, Connecticut

Small cylinders

We could use single- acting cylinders with bore sizes under 1½ inch. It would simplify circuitry and permit smaller, lighter cylinders. Also rod end bearings on ends would help.

R. CASSIN
Experimental Engineer
Lycoming Division
Avco Corp.
Stratford, Conn.

Reduce heat & friction

We utilize hydraulic power and control in most of the equipment we develop. One of our principal problems in these applications is supplying sufficient power at the source to overcome the friction and heat losses encountered throughout the system. I would suggest that a basic need in the hydraulic field is to furnish components that minimize heat losses and eliminate the need for coolers. This must take place in the pumps, the fluid, the relief and control valves, as well as all fittings. Is there a possiblity of introducing pulsations in the fluid flow which might help overcome friction?

A great deal must be done with hydraulic fluid itself to suit it for use as the proper medium for transmitting force. Internal friction must be reduced to zero and in the event of excessive heat it must retain sufficient body to keep mechanical parts lubricated.

Internal passages in pumps and valves must be better designed to pass fluid without turbulence and friction. Basic components such as hose ends, fittings, connnectors, etc. must be made more reliable. In portable systems, quick disconnect connectors must be provided which will not leak or introduce dirt into the system whenever connected or disconnected.

MARSHALL LONG
President
Research Engineering & Development Co.
Overland Park, Kansas

▼▼▼

MOLDED SEALS

Complete Stocks

Dependable Engineering Service

LINEAR SEALS
"O" Rings
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Valve Packings
Diaphragms
Bonded Parts
Gaskets
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ELASTOMERS
Natural Rubber
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Buckeye Rubber & Packing Co.

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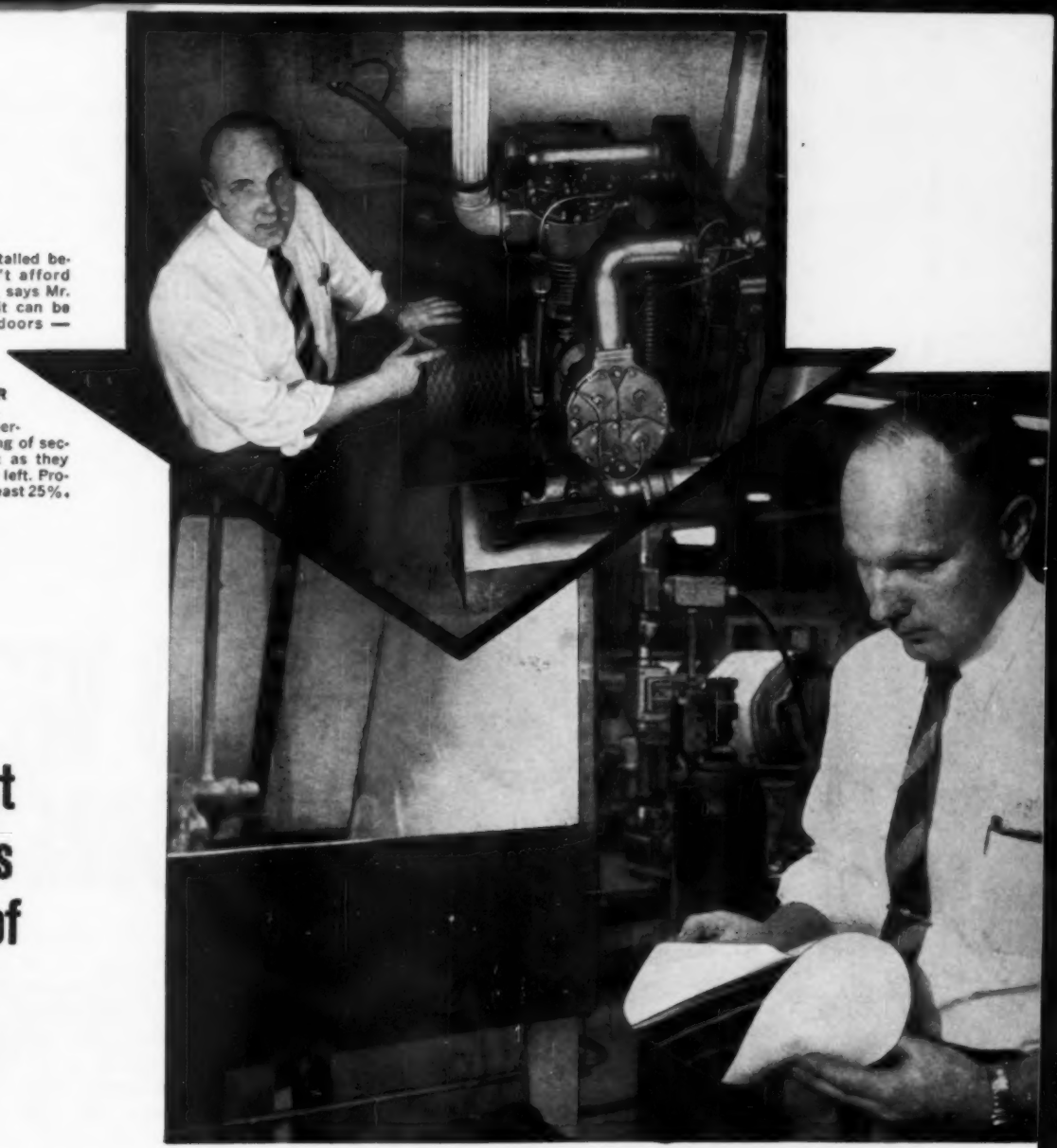
Circle **21** on Reader Service Card

Circle **88** →



LE ROI 50S2 was installed because Bowes couldn't afford compressor downtime, says Mr. LaFara. Air-cooled unit can be used indoors or outdoors — needs no plumbing.

FINISHED TIRE REPAIR SECTION is inspected. Compressed air now permits automatic spraying of sections with liquid latex as they pass through booth at left. Production increased at least 25%.

This plant minimizes the risk of "no air - no work" with a

LE ROI 50HP STATIONARY COMPRESSOR

A dependable compressor headed the list of critical needs when Bowes Seal Fast Corp., of Indianapolis, Ind., merged two plants under one roof. A Le Roi 50S2 two-stage compressor provides this vital dependability . . . and all the compressed air needed to produce over 2000 various items for the upkeep of cars, tires, and tubes.

James S. LaFara, Plant Manager, reports that the Le Roi unit delivers 210 cfm at 125 psi . . . operates 75% to 80% of 8- to 16-hour production days, five days a week, and supplies almost 100% of all the compressed air needed. Down-time, he adds, is at a minimum, and maintenance costs are below those of two smaller compressors which the Le Roi replaced, and which now serve only as standby units.

Look what this Le Roi 50S2 does! It provides air to spray tire-repair sections (boots) and tubeless-tire repair plugs with a mixture of liquid soap and water. The unit powers latex spraying machines, and blows scraps from tube-patch cutting machines. Other uses include air for lead moulding equipment, nut-driving units, cleaning vents on chemical filling machines, and for the plant's fire-protection system.

Are you looking for a "dependable" compressor? Check the complete line of Westinghouse unit-type and Le Roi stationary air compressors — from ½ to 100 hp. Contact your Le Roi distributor, or write to Le Roi Division, Westinghouse Air Brake Co., **Sidney, Ohio.**

SC-08

LE ROI STATIONARY COMPRESSORS

PORTABLE AND TRACTAIR® AIR COMPRESSORS • STATIONARY AIR COMPRESSORS • AIR TOOLS

Selection of finest raw materials

Testing every step of the way

Inspection to rigid standards

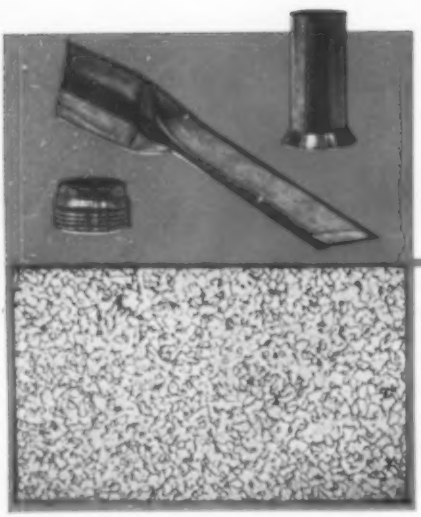
Assure 100% dependability for

OHIO WELDED PRESSURE TUBING

You can be sure — doubly sure — of utmost tubing dependability when you specify Ohio Welded Pressure Tubing — *made by Ohio Seamless.* First, Ohio works to accepted industry standards — ASTM, ASME, and similar Federal and military specifications covering welded pressure tubing. Second, Ohio Welded Pressure Tubing is produced under a *continuous* process of quality control — not just a final test inspection to cull questionable material.

Carefully selected prime raw material is slit, edged, shaped and electric resistance welded on the most versatile and modern equipment in operation. At each and every step of the way Ohio Welded Pressure Tubing is under the scrutiny of Ohio's master tubemakers . . . making control tests at frequent intervals . . . testing random samples from each production order far beyond the limits of the usage involved.

For critical pressure piping applications . . . for condensers, heat exchangers, boilers and superheaters — in the range of sizes from ½ to 7½" OD and wall thicknesses from .028 to .375"— mark your prints "*Ohio Custom Made Welded Pressure Tubing.*" There is no equivalent.



Photographs show flare, flattening and crush tests performed continuously on every order. Non-destructive tests include air, water, magnetic, eddy current and visual inspection to insure 100% dependability.

Photomicrograph of polished and acid-etched surface shows perfect microstructure of normalized Ohio Welded Pressure Tubing. Weld area running down the center is now indistinguishable and tube has become, in every sense, weldless.

OHIO

OHIO SEAMLESS TUBE

Division of Copperweld Steel Company

SHELBY • OHIO

Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging

Representatives in principal cities. Check leading directories:
THOMAS', MacRAE'S, CONOVER-MAST, SWEET'S, FRASER'S.

A-4500A

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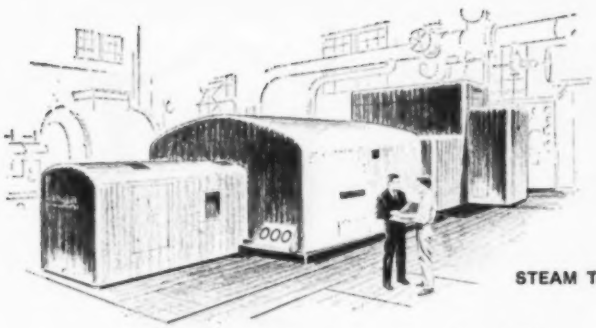
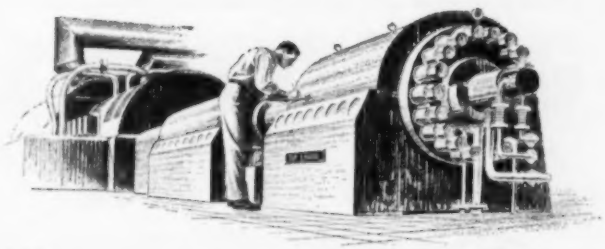
engineered dependability has helped keep America strong for 60 years

Since 1901, De Laval has helped keep America strong by supplying high-quality, precision-built equipment to almost every industry and service. In refineries . . . power plants . . . steel mills . . . mines . . . waterworks . . . pipelines . . . paper mills . . . the armed forces and the merchant marine, De Laval's engineered dependability has helped strengthen our country's economy and defenses for 60 years.

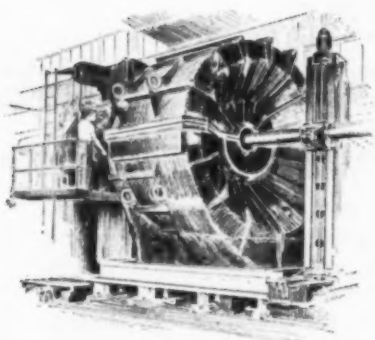
De Laval Steam Turbine Company, Trenton 2, N. J.



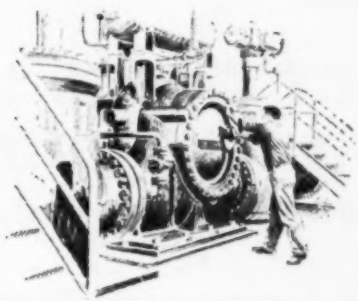
STEAM TURBINES



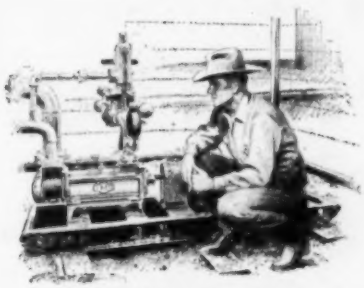
CENTRIFUGAL PUMPS



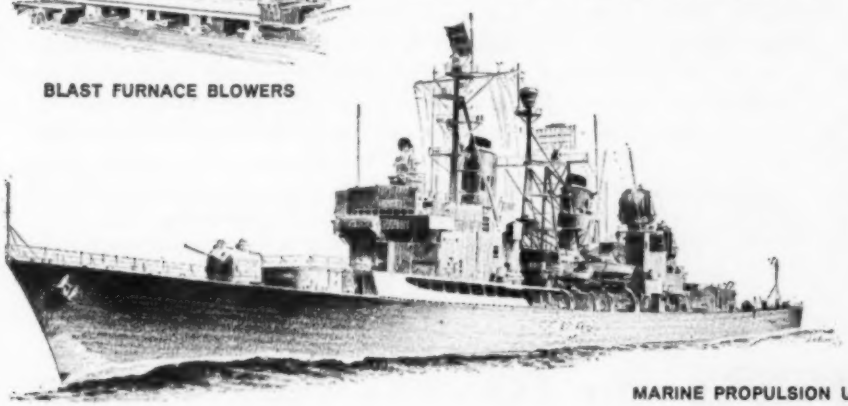
BLAST FURNACE BLOWERS

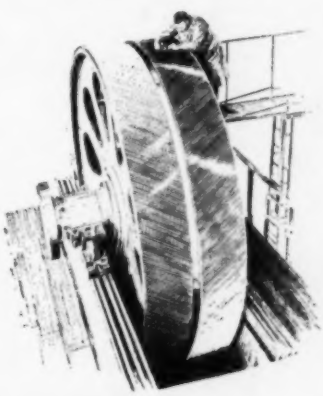


SINGLE- AND MULTI-STAGE COMPRESSORS



IMO® ROTARY PUMPS





MARINE PROPULSION UNITS AND AUXILIARIES

MG-DL-112

DE LAVAL · 60 YEARS OF CREATIVITY AND QUALITY

CENTRIFUGAL PUMPS AND COMPRESSORS • TURBINES • IMO® ROTARY PUMPS AND HYDRAULIC MOTORS
MARINE PROPULSION AND AUXILIARY EQUIPMENT • HELICAL AND EPICYCLIC GEARS • TURBOCHARGERS

YOUR PRODUCT COSTS LESS AT THE END OF THE LINE

when you start with B&W Job-Matched Mechanical Tubing

Here's how B&W makes unit cost savings possible on machined, formed and structural parts. First, B&W gives you unbiased assistance in choosing the proper stainless, alloy or carbon steel grade of seamless or welded tubing. Uniform physical and mechanical properties—hot or cold finishing—standard or special tolerances—proper heat treatment—are then built into the tube depending on your fabricating procedures and end-use application. When B&W Job-Matched Mechanical Tubing goes on the line you can be sure it's as close as possible to the finished part. It also has optimum machinability or formability. The result: some fabricating operations are eliminated. Others are speeded up. Your end product comes off the line at maximum rate of output—at minimum unit cost.

Make good fabricating sense? To find out more, contact your local B&W District Sales Office or Steel Service Center. Meanwhile, write for Bulletin TB-430. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

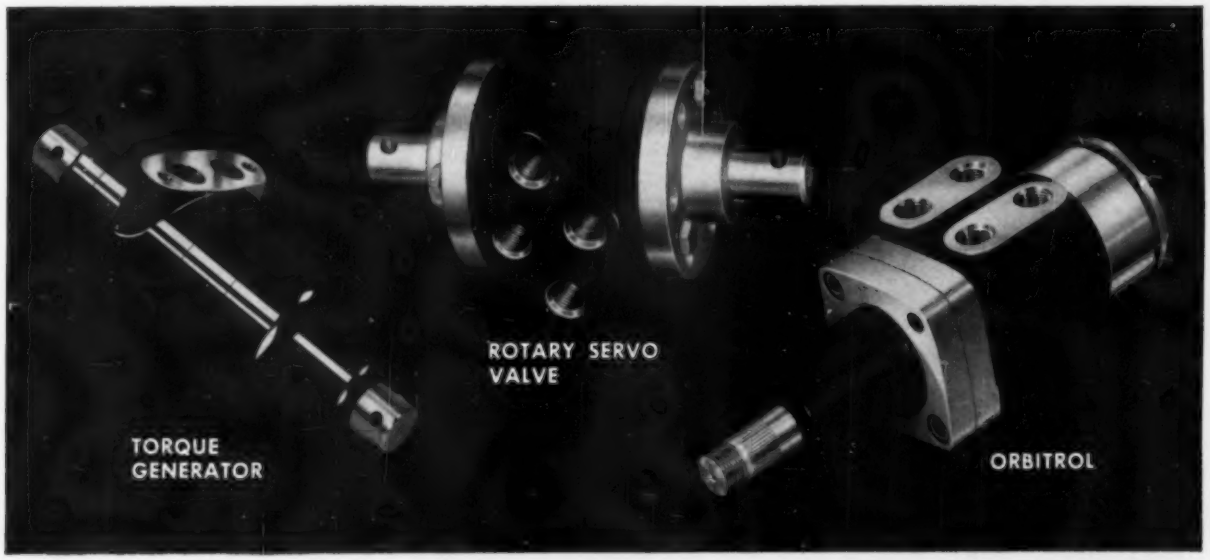
B&W

THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

TA-1012-M

Seamless and welded tubular products, solid extrusions, rolled rings, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals



Char-Lynn POWER STEERING

Now available for *all* Types of Vehicles

3 Basic Controls • 30 Standard Models

TORQUE GENERATOR is used to furnish POWERED OPERATION or TORQUE AMPLIFICATION to mechanical steering systems.

This remarkable steering control contains both a Servo Valve and Orbit Motor which delivers up to 1,100 in. lbs. of torque output at 1,000 PSI system pressure. Manual effort at the steering wheel is approximately 30 in. lbs.

Direct thru linkage within the unit provides means for manual steering of the vehicle during "engine off" or emergency conditions.

ROTARY SERVO VALVE is a remote control for steering systems where it is desirable to actuate the linkage by a hydraulic cylinder. Pressure feed-back provides "load feel" at the input shaft proportional to operating pressure. Also contains direct thru linkage for manual steering.

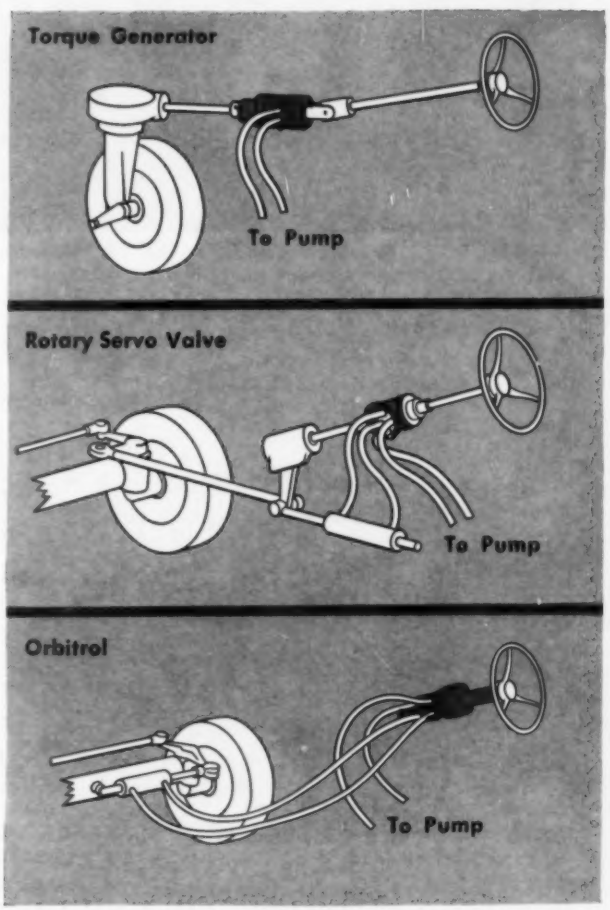
Although designed primarily for power steering systems, this versatile valve has unlimited use in other applications requiring remote servo control.

The all new ORBITROL is a completely integrated fluid steering control that eliminates any mechanical linkage to the axle. The ORBITROL provides remote rotary servo control with sensory direction and delivery measurement within the same unit.

The hydraulic motor section of the Orbitrol functions as a metering device during normal power steering operation and reverts automatically to a rotary hand-pump for emergency manual control.

For complete information write:

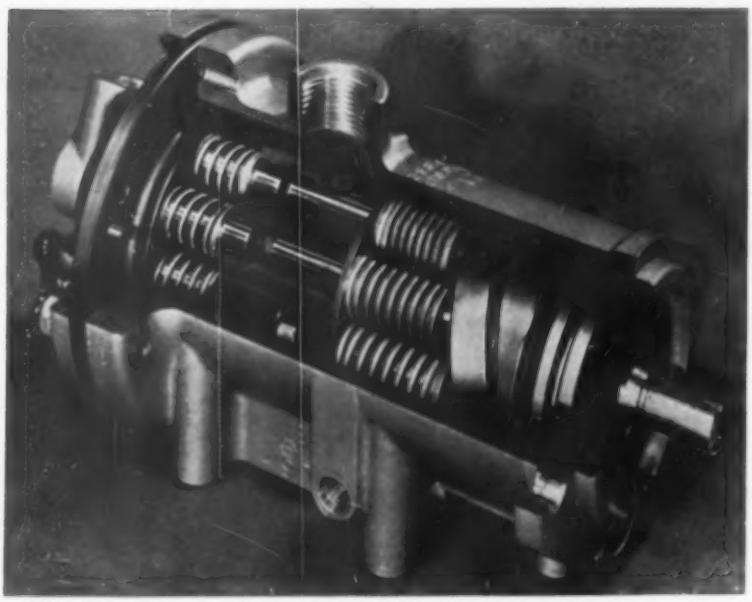
Char-Lynn Co., Dept. P-3
2843 26th Avenue South
Minneapolis 6, Minnesota



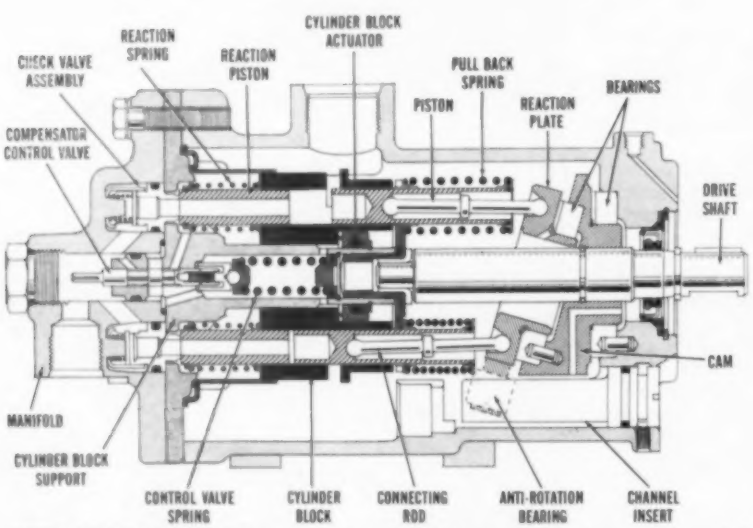
FLUID POWER AT WORK

keeping up with design, application, methods

Axial Piston Pump Has Balanced Design



PUMP WEIGHS 14 lb. and measures 9⅝ in. long, 5⅜ in. dia. maximum.



DRIVE SHAFT AND CAM are pump's only rotating parts. Displacement is varied by shifting cylinder block to control effective piston stroke. Actual piston stroke remains constant.

CLEVELAND—A new axial piston pump, intended for industrial, mobile equipment, and marine applications, has a hydraulically balanced displacement control which virtually eliminates pumping forces from the displacement-changing mechanism. Pressure compensation is also available with manual displacement control. The pump, introduced by The Weatherhead Co., has seven pistons which reciprocate in a non-rotating cylinder block. The pistons are driven by an oscillating reaction plate actuated by the pump shaft and cam which are the only rotating parts. Displacement is regulated by shifting the cylinder block to control effective piston stroke. Delivery is 9 gpm at 3600 rpm (continuous) 3000 psi.

Reaction pistons balance hydraulic forces on the cylinder block during pumping and reduce the force required to change displacement. Direct cylinder block actuation at low force level, provides sensitive, fast response and stable control. The non-rotating cylinder block avoids centrifugal forces on the reciprocating components, permitting pump speeds to 4500 rpm.

Mechanical efficiency is increased because there are only two moving parts, and because side loads on the pistons are minimized by long, self-aligning connecting rods in spherical seats. The elimination of side loads also contributes to long service life and permits pumping fluids of low lubricity. The pump can operate at no flow while maintaining full sys-

Continued on page 26

HUNT

Air and Hydraulic

CONTROL VALVES

Whatever the application . . . whatever the service . . . whatever the pressure range . . . whatever the size . . . whatever the actuation required . . . chances are you'll find a valve in the Hunt line *exactly* suited to your needs.

Sizes range from ⅛ through 8 in. for vacuum to 300 psi air and for water, soluble oil and water, or oil to 5000 psi.

Your nearby Hunt representative will be pleased to work with you. You'll find him listed in Sweet's Product Design File.

HUNT

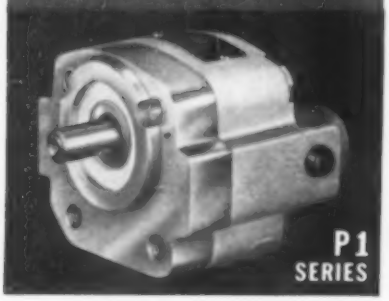
QUICK-AS-WINK® AIR AND HYDRAULIC

VALVES

HUNT VALVE COMPANY • DIVISION OF IBEC • SALEM, OHIO

For more information, write for Bulletin 603. Address Dept. AH-1061, Hunt Valve Company, Salem, Ohio.

TO PUT YOUR HYDRAULIC POWER TRANS-MISSION IDEAS TO WORK:



CAPACITIES:
0.4 TO 1.6 GPM AT
2000 RPM AND 2000 PSI
DISPLACEMENT:
.05 TO .20 CU. IN.
MAXIMUM SPEED:
4000 RPM

Pressure loaded* for higher efficiency, longer life—Optional side, rear or combination porting—Special alloy tin-aluminum bearings as used in heavy-duty industrial engines, all interchangeable—Double lip shaft seal—Hardened and ground steel gears and shafts—High quality, high tensile aluminum bodies and covers.

Consult our Engineering Department for application of these pumps at higher pressures.

*Patent Nos. 2420622, 2803515, 2804522

WOOSTER DIVISION BW

BORG-WARNER CORPORATION
WOOSTER, OHIO
For Mechanical Power Transmission, See Warner Automotive Division
Circle 157 on Reader Service Card

FLUID POWER AT WORK

tem pressure.

Individual discharge check valves avoid cavitation effects, even at inlet pressures as low as 20 in. Hg or lower. ▼▼▼

Reinforced Piston Lifts Jet Engine

Seven hydraulic cylinders can be operated from one source of power in this multiple lift system developed for jet engines by Wayne Pump Canada Ltd. This system has a low initial cost, is more economical to operate, and provides more reliable lift shifting than systems in which each lift has its own individual motor and pump installation.

When a jet engine requires maintenance or repair work, it is bolted to the lift piston which is lowered into a pit. It can be stopped at any level convenient for reapir work.

Each lift piston is stiffened to eliminate deflection or whip action caused by off-center or unstable

Continued on page 28

BRIEF NOTES

STRESS DESIGN AND USE OF SOLENOID . . . To meet the increasing and diversified use of solenoids, Controls Company of America has created a new division: Industrial and Commercial Control Sales Dept. Its purpose is to help industry use more solenoids in more applications.

NEW INDUSTRIAL FILTER DIVISION . . . The Warner Lewis Co., Tulsa, Oklahoma, a subsidiary of Fram Corp., has announced the formation of a new Industrial Division. The division will develop a complete line of filters for liquids and gases.

CREATE OVERSEAS HYDRAULIC OPERATIONS . . . Commercial Shearing & Stamping Co., Youngstown, Ohio, has announced plans for the immediate establishment of European operations in Switzerland, Great Britain, and Luxembourg to assemble and market its fluid power hydraulic components. Products produced at the new plants will include pumps, motors, and valves for construction, mining, and material handling equipment.

FREE PLUMBING SERVICE AVAILABLE . . . Parker Fittings and Hose Division of Parker-Hannifin Corp. has equipped a truck with a built-in shop, and sends it to manufacturers of industrial and mobile equipment who have plumbing problems. An experienced mechanic bends and installs all plumbing on the manufacturer's prototype machine. Cost for this service: the price of materials used.

LICENSING AGREEMENT SIGNED . . . The S-P Mfg. Corp., Cleveland has signed a licensing agreement with the Compagnie Parisienne d'Outillage a Air Comprime, Paris, France to manufacture and market S-P non-rotating cylinders, boosters, and air/oil tanks.

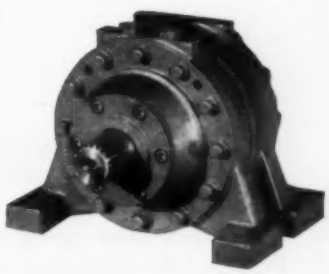
CYLINDER MANUFACTURER WINS AWARD . . . The National Industrial Relation Association has given its 1961 Class AA Helms Industrial Recreation Award to the Miller Fluid Power Div. of the Flick-Reedy Corp. The company received the award for operating the most outstanding employee recreation program among North American Companies with less than 500 employees.

NEW FILTER MANUFACTURER . . . Michigan Wire Cloth Co., Detroit is now manufacturing filters in addition to wire cloth, strainers, and filter elements. Filters are available in standard 100-mesh (140 micron), and 60, 80, 150, and 200 mesh for filtering particles from 260 to 75 microns. Filters are monel wire mesh and cadmium-plated steel.

BENDER FOR 14" OD PIPE . . . The Costello Engineering Corp., Gardena, Calif., is designing a 70-ton pipe bender to bend pipe of 14 in. OD x ½-in. wall thickness.

"OK, OK, so Houdaille's HydRoAc comes in 80 different variations. So now can we go to dinner?"

Go ahead. Live it up. Your rotary actuator problems are over. Houdaille's HydRoAc can be used to turn, lock, index, steer, bend, clamp, lower, open, swing, lift, tilt, drive, revolve, meter, mix and do lots of other jobs. It's the only hydraulic rotary actuator that gives you efficiencies to 95% or over, with low internal leakage. The 80 variations of HydRoAc range in torque from 1500 to 228,000 inch pounds at 3000 p.s.i. (Operating pressure can be as low as 50 p.s.i.) These units are highly responsive for servo system use, and provide angular travel up to 280°. Why not get the full story on Houdaille's HydRoAc. Send for your HydRoAc catalog before dinner tonight.



... Specialists in rotary type hydraulic equipment

Houdaille Industries, Inc.

Buffalo Hydraulics Division · 545 E. Delavan Ave., Buffalo 11, N. Y.

DESIGN ESSENTIALS FOR BETTER HYDRAULIC PACKINGS

THESE BASIC FEATURES are part of "John Crane" Hydraulic Packings. They assure packings that meet the most rigid requirements of hydraulic service ...a good initial seal, long life, efficient performance over wide pressure ranges and stability in the fluid medium.

1. Pressure access allows immediate pressure distribution and packing response.

2. Ball joint nesting surfaces facilitate breathing without pinching, wedging or lip collapse.

3. Adequate lubrication reservoir.

4. Uniform bottom thickness eliminates weak points and insures centerline hinge action.

5. Molded-in lip interference insures tight static seal and conformation to bore and rod deflections.

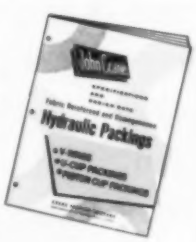
6. Heel clearance prevents "riding" at heel and eliminates lip toe-in.

7. The fabric in the "V" rings is so laid to assure maximum strength—an important consideration for maximum packing life.

Tell us about your standard requirements and ask for recommendations and/or assistance in the creation of a combination of packings that will best handle individual operating conditions. Request Bulletin P-333 for general information.

Crane Packing Company, 6405 Oakton Street, Morton Grove, Ill. (Chicago Suburb).

In Canada: Crane Packing Co., Ltd., Hamilton, Ont.



John Crane

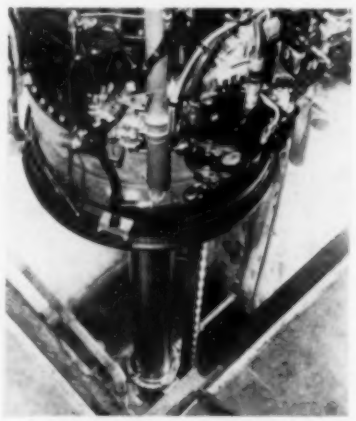
MECHANICAL PACKINGS · SHAFT SEALS · TEFLON PRODUCTS · LAPPING MACHINES · THREAD COMPOUNDS

CRANE PACKING COMPANY

Circle **34** on Reader Service Card

loads. The interior of the piston is lined lengthwise with serrated steel reinforcement bars welded to the ends of the piston, and the piston is filled with concrete. This construction is four times more rigid than a standard piston of the same size.

The company also developed a way to remove the entire cylinder assembly in case a lift must be relocated. Formerly, when a pit was



PISTON AND ENGINE go into 8-foot pit. Lift will lower engine to working elevation convenient for mechanics standing on floor. Safety leg beside piston keeps it from rotating.

abandoned and filled in, the equipment in the pit was left in it and was lost. The new cylinder casing is anchored so that a sharp upward pull will disengage it from the pit leaving only a single support plate in the bottom of the pit. This allows a shop to salvage the lift whenever it must be moved.

Each lift is fitted with a safety leg which prevents the piston from rotating and a damaging drop in case hydraulic pressure fails.

Pressurized air stored in an accumulator maintains constant pressure on the oil that actuates the lift. There is enough air stored under pressure to operate all the lifts at one time.

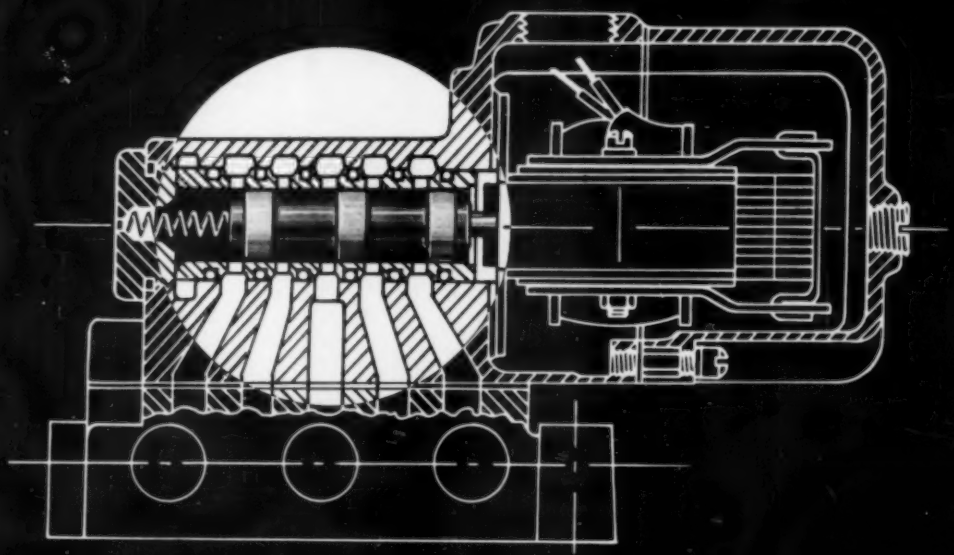
A series of floating and pressure-sensitive valves prevents any mixture of air and oil which might cause a pressure failure and damage to equipment. With an accu-

Continued on page 30

Circle **107** →

NUMATICS *makes a superior valve—*

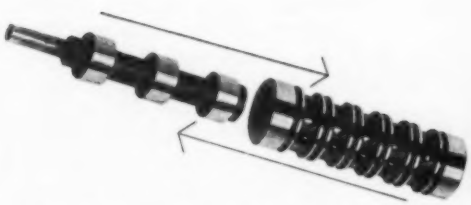
a simple, versatile valve!



It works...

and works...

and works!



Famous floating sleeve-lapped spool design.

TO FIND OUT WHY CONTACT

NUMATICS, Inc.

Highland, Michigan

mulator in the system, it is not necessary to run the pump each time a lift is raised.

An auxiliary motor and pump cut in automatically if the main components fail. This assures constant and reliable hydraulic power. Lift speed is infinitely variable from zero to 12 fpm. Controls are sensitive enough to position equipment to within a few thousandths of an inch for alignment or fitting.

Book Review

Pipe Friction Manual, *Third Edition, Copyright* 1961, 90 *pp., The Hydraulic Institute,* 122 *East* 42*nd St., New York* 17, *N. Y.*

The material in this manual is an extension and rearrangement of pipe friction data contained in the previous edition and in an earlier publication titled "Tentative Standards of the Hydraulic Institute—Pipe Friction."

The manual features a section demonstrating the mathematical calculations used in the construction of charts. It includes complete tables of friction loss for water in feet per one hundred feet of pipe. Wrought iron, steel and cast iron pipe sizes from ⅛ in. nominal to 84 in. ID are given. Tables show resistance coefficients for valves and fittings, 90-degree bends, and diffusers. Tables of resistance coefficients for valves and fittings include latest available experimental data, and show these values in detail with respect to size and type.

Full page charts showing the friction loss for the incompressible flow of viscous fluids for pipe sizes from ½ through 12 in. are included.

BHEW

Hydraulic Cylinders

- Basic Designs
- Specific Adaptations
- Superior Quality
- Application Engineering

BHEW'S HOLLOW ROD CYLINDERS are two piece tubular rods that allow oil to flow through the rod in two separate channels to operate double-acting cylinders. You benefit from this application because the cylinder barrel is plain without port connections and the rod is anchored in a stationary position. The barrel is the reciprocating member.

- Eliminates hydraulic line connections to the cylinder barrel.
- Especially successful for boom extenders, out-riggers, etc.
- Hollow rod cylinders are partially constructed around standard components.

Production parts save you money, do the job better! BHEW basic cylinders can easily be modified to fit your *specific* product applications. You benefit from production economies; you get custom-built cylinders.

Let's discuss your design and application problems —

FREE!
Write today for Hydraulic Cylinder Engineering Reference Data — 78 dimensional basic designs for general — and special-purpose double-acting cylinders. SAVE TIME.

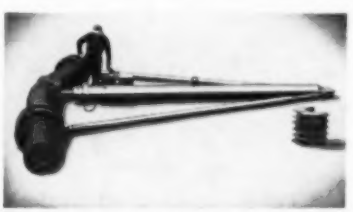
BENTON HARBOR ENGINEERING WORKS, INC.
622 Langley Avenue, St. Joseph, Michigan

Circle **19** on Reader Service Card

Portable Bender Bends Pipe Up to 18" OD

A tube bender especially designed for field use, has been developed by Chamberlain Industries Ltd., Leyton, England. It can bend mild steel pipe up to 18 in. OD, ½ in. wall thickness.

Conventional forming heads are replaced with two pivoting arms to which the pipe clamps are fitted. This way, the pipe being bent



AIR-OIL PIPE BENDER can make a 10-degree bend in one thrust.

forms a part of the machine's structure. These arms are adjustable at the rear of the machine. Increasing the ram stroke also increases the bending angle.

An air/oil hydraulic pump, powered by a small compressor or shop air, supplies the power required to actuate the bender's hydraulic ram.

ADEL...offers you *single source* responsibility

for precision hydraulic power pumps

CONSTANT DISPLACEMENT GEAR TYPES WITH ELEVEN DIFFERENT GALLONAGE OUTPUTS... DESIGNED FOR 1000 PSI SERVICE WITH RATED CAPACITIES OF FROM 1.4 TO 47.5 GPM AT 1800 RPM

Precision-built for long, trouble-free service under the most severe operating conditions, they exceed the requirements for a low cost, efficient power source. Highest volumetric and hydraulic efficiency—rugged simplicity—only two moving parts—the impeller assemblies, which roll together with minimum wear and horsepower loss.

- Pumps operate at higher speeds than most competitive units and permit use of smaller pumps and motors for a given horsepower requirement, thus reducing initial cost.
- The unusual drive design of the impeller gear minimizes wear between the gear and end plates. Pumps are self-lubricated. No grease fittings to service and no external drain required.
- Special shaft seal assures positive sealing, eliminates packing difficulties. Precision gear type construction makes a quieter operating pump. Ratio of volume output to pump size unusally high.

The Pumps With Maximum Operating Efficiency Over The Years
Let ADEL be your **single-source** *for* **precision hydraulic equipment**
Write for pump brochure containing complete specifications.

Designers & Manufacturers of Industrial & Marine Hydraulic Control Equipment

Reliability
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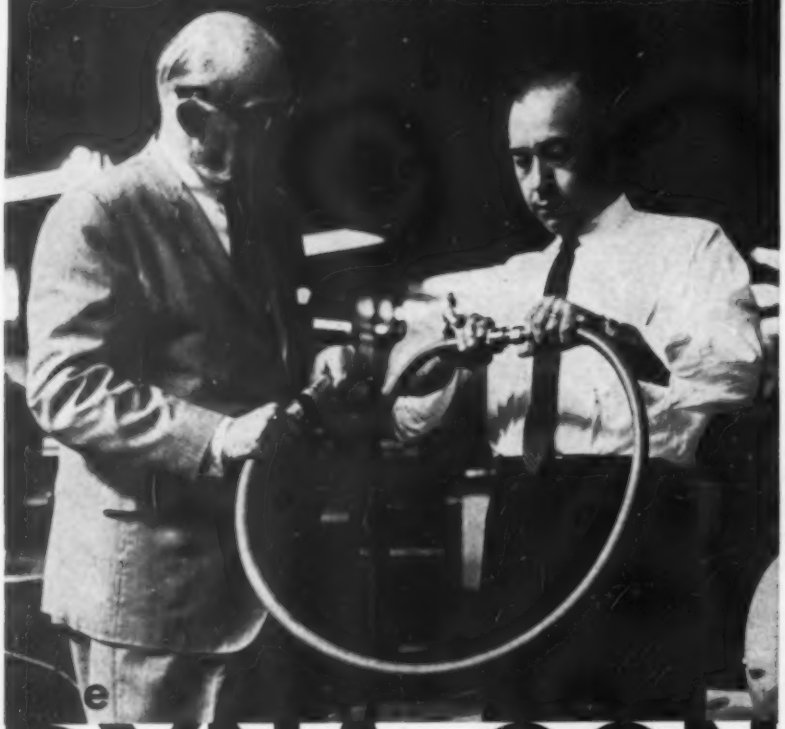

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DOES OBSOLETE YOUR PRESENT PNEUMATIC COUPLINGS

Don't take our word for it. We've told you that the DYNA-CON OBSOLETES present pneumatic couplings . . . that it's the easiest to connect by far . . . the safest by far . . . and the most economical as well! If we were in your shoes, we'd want proof. Let us prove it to you with our simple five minute demonstration in your plant. Call, write or wire DYNA-QUIP today . . . prove to yourself how revolutionary the DYNA-CON really is!

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Circle 41 on Reader Service Card

FLUID POWER AT WORK

Butyl Hates Oil

Poor service life from a butyl rubber packing compound may be caused by contamination of the fire-resistant hydraulic fluid with mineral oil, according to E. F. Houghton & Co., Philadelphia.

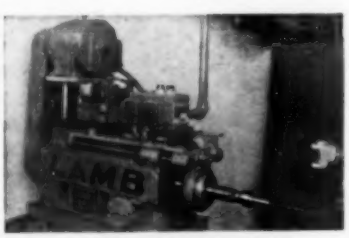
Butyl rubber is normally unaffected by either water glycol or phosphate ester hydraulic fluids. Unfortunately these fluids can become contaminated with mineral oil which creeps into the system through leakage, careless servicing, or inadequate flushing. The latter is the most common cause.

If water glycol is used, and the system becomes contaminated with mineral oil, nothing happens because the two do not mix. The oil floats on top where it can be seen and removed.

If phosphate ester fluid is used in the hydraulic system, and it becomes contaminated with mineral oil the butyl packings are attacked by the oil and tend to disintegrate. An analysis of the fluid will quickly determine the presence of mineral oil.

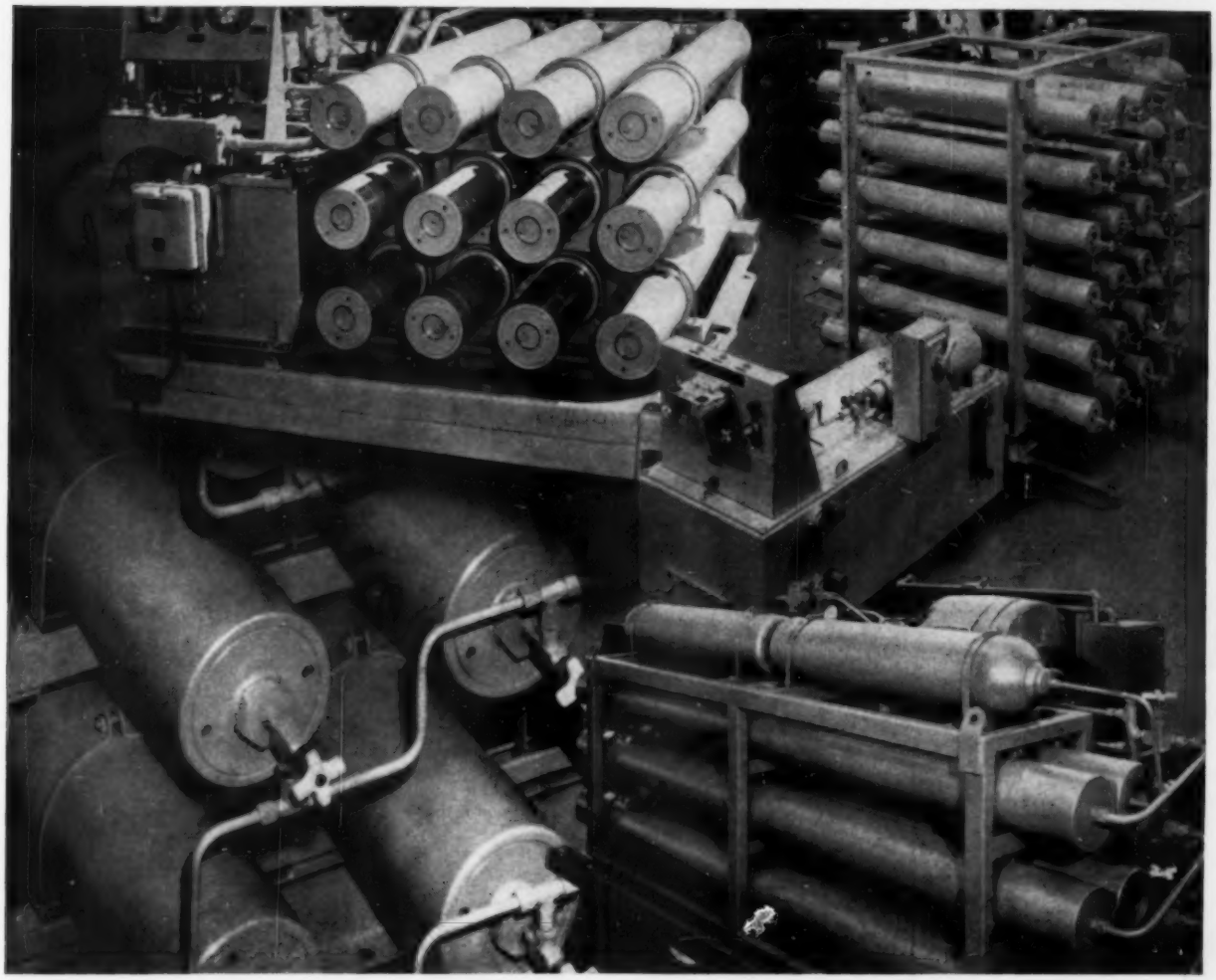
Here is a quick guide for compatibility of packing and fluid:

Packings	Oil	Phosphate Ester	Water Glycol	Water-Oil Emulsion
Buna N	ok	no	ok	ok
Butyl	no	ok	ok	no
Leather	ok	ok	no	ok



BAYONET TYPE FILTER is used in this tilting quill unit. This 40-micron filter made by Rosaen Co., Hazel Park, Michigan, signals the need for cleaning by showing how much pressure is required to force the fluid through it. The quill units, manufactured by F. Jos. Lamb Co., Detroit, uses the filter as standard optional equipment.

Now...more new accumulators from AMERICAN BOSCH!



AMERICAN BOSCH ACCUMULATORS
are tailored to fit the job!

Now—American Bosch offers the most complete line of piston-type accumulators on the market! Sizes range from less than a quarter pint to twenty gallons. Models are available for a variety of pressures in both steel and aluminum—in many diameters, lengths and capacities to handle any job.

American Bosch accumulators are designed and manufactured to meet the most rigid requirements. They combine many features to provide the utmost in performance and reliability.

When you specify accumulators for hydraulic systems—call for AMERICAN BOSCH ACCUMULATORS! Details are included in folder AC 110-02-2. Write for a copy and the name of your nearest distributor.

AMERICAN BOSCH ARMA CORPORATION

Commercial Sales Division • Springfield, Massachusetts

MOVE AHEAD with AB

ACCUMULATORS FOR INDUSTRIAL, MARINE AND MOBILE APPLICATIONS

Are you keeping your O-ring Quality up?

"For want of a nail..." The same burden may often fall on the tiny O-Ring. In overall product reliability the smallest parts are vital to performance. That's why IPC uses the famed "custom" approach in designing and manufacturing O-Rings.

Analyzing your application in terms of extensive compounding experience . . . IPC then customize tooling and manufacture under the most exacting quality control standards in the O-Ring industry.

Next time, in fact *anytime*, you suspect O-Rings are a critical factor in product performance, ask your IPC sales engineer to lend a hand. He has some interesting data which can help you evaluate O-Ring performance!

IPC

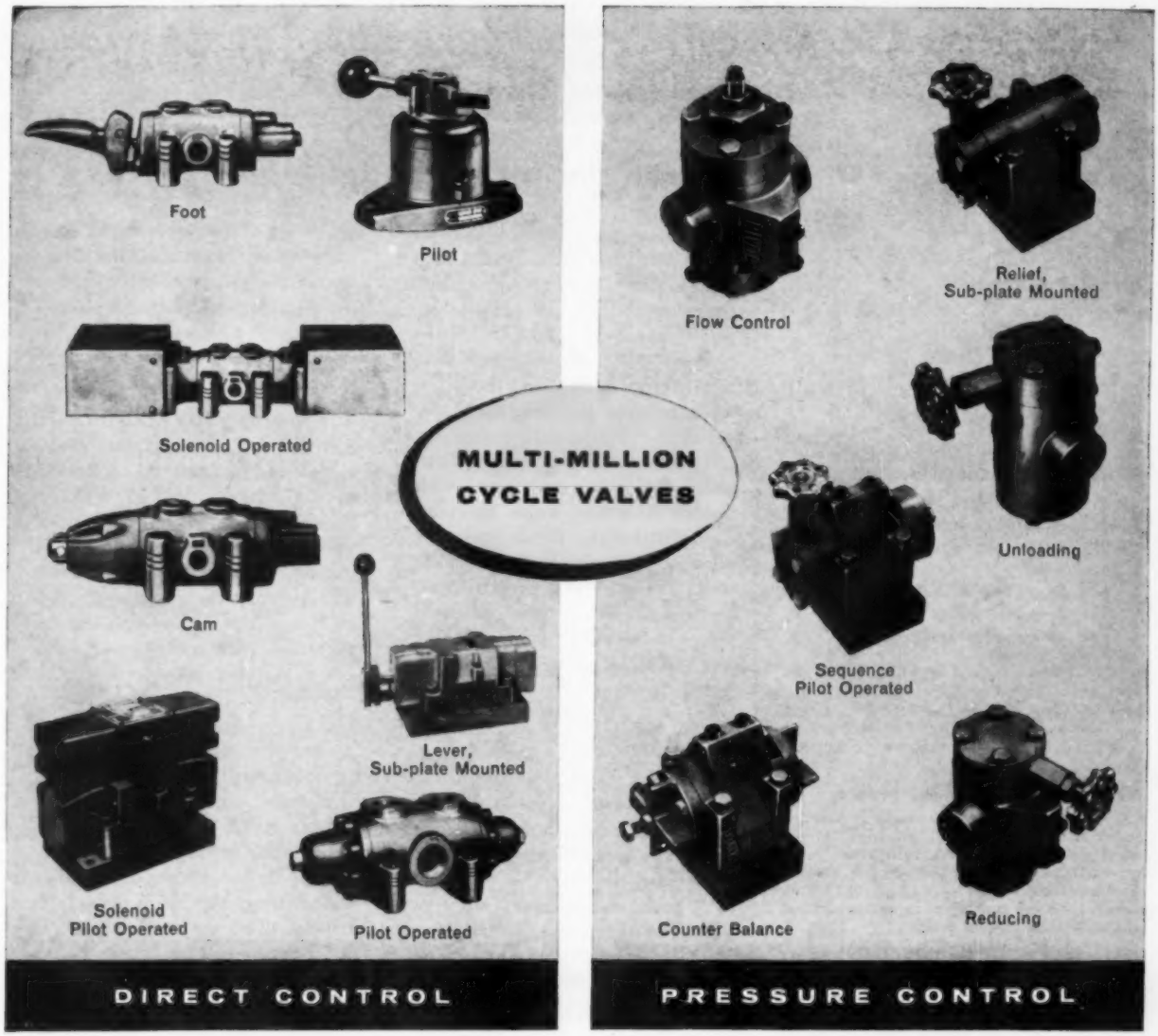
OIL SEALS
PACKINGS
PRECISION MOLDING *Custom designed for your application*

INTERNATIONAL PACKINGS CORPORATION

Bristol, New Hampshire

®IPC

P4



RIVETT... *is the one source for the correct valve, to control all or part of any hydraulic circuit!*

Whatever your requirements, you can find the right valve at Rivett. Save time, money, inventory and maintenance with these most advanced designs. Greater flow capacity; minimum pressure drop; positive damping and operating stability. From single basic assembly of functional valve any one of six functions may be obtained. Over 400 standard models—sub-plate and pipe mounted; direct control and functional. Pressures 1500 and 3000 P.S.I. All actions, all piston designs, all operations. Sizes ¼" to 2". J.I.C. standards.

RIVETT LATHE & GRINDER, INC.
Dept. HP-10, Brighton 35, Boston, Mass.

The Better You Know Hydraulics—
The Better You Like

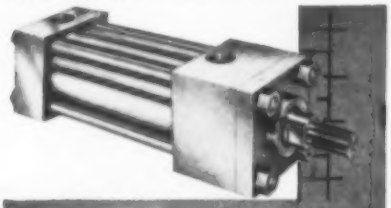
Cat.'s 204, 210, 230 and 261 contain 68 pages describing all valve models, sizes and types with complete working drawings, specifications, performance, ratings, cut-away views. Get free copies today.

RIVETT
HYDRAULIC VALVES

Circle **127** on Reader Service Card

NEW O-M SQUARE-HEAD AIR AND HYDRAULIC CYLINDERS

GIVE THE PERFORMANCE YOU EXPECT... AND MORE



Air—(rated 200 psi)
Hydraulic—(rated up to 2000 psi)
Meet JIC Standards 1 ½" to 14" Bores

Long Service
Uniform Performance
Dimensional Interchangeability
High Operational Efficiency
Compact — Saves Space
Quick, Easy Maintenance

Made of the highest quality materials and seals, these new components combine modern design, the latest and best engineering advancements with O-M specialized "know how" and precision workmanship.

New Series "K" Air Cylinders

Construction features include brass cylinder barrel, chrome-plated, high tensile steel piston rod with a minimum yield strength of 90,000 to 100,000 psi. Rolled and machined steel heads and extra long cartridge-type rod bearing assure perfect alignment of piston rod.

New Series "L" Hydraulic Cylinders

Similar in many construction features to Series "K", but specifically designed for hydraulic service. Incorporate vee-type rod packing and a cylinder barrel of micro-honed steel tubing which are best suited for hydraulic operations.

With the addition of the new Series "K" and "L" to the Ortman-Miller major line of air and hydraulic cylinders, you can now rely on O-M for *all* of your low and medium pressure cylinder requirements.

Mail coupon today for complete details. All cylinders in Bulletins 115A and 116 have been dimensioned in accordance with NFPA recommendations for your convenience.

ORTMAN-MILLER MACHINE COMPANY
1143rd Street, Hammond, Indiana

☐ Have representative call
Please send Bulletin(s)
☐ 115A—Series "K" ☐ 116—Series "L"

NAME_____
POSITION_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE____ STATE_____

Circle **109** on Reader Service Card

FLUID POWER AT WORK

Power closing for large water valves

When a conventional 24-in. water gate-valve is connected to a 100-psi line, force acting against the face of the valve disk is approximately 45,200 lb. With manual operation, two men had to turn a large hand wheel about 150 turns to open or close the water valve.

To make the job easier, Pittsburgh Controls collaborated with Golden Anderson Valve Specialty Co., Pittsburgh, in designing a pilot system which uses system water pressure as power to open or close the main valve. Solenoid valves in the pilot system are energized with the starter for the water pump drive motor.

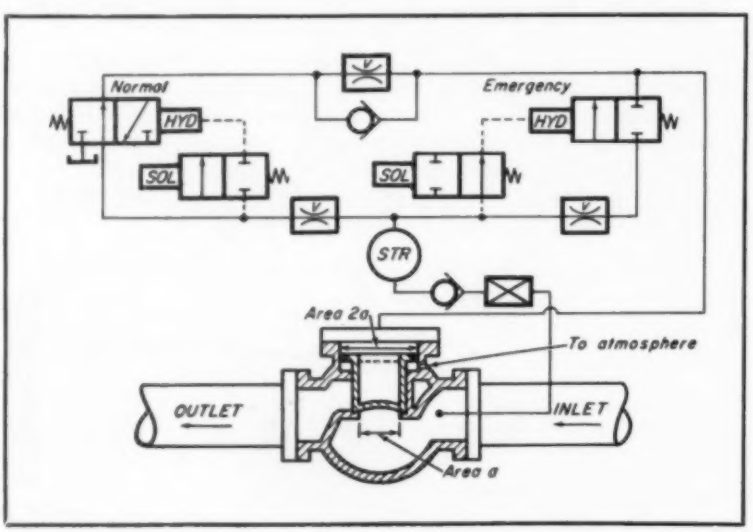
• **Normal Operation**—When the water pump is started, both solenoid valves are actuated. The top of the water valve is drained through the normal valve. Pressure under the water valve piston lifts it, opening the valve.

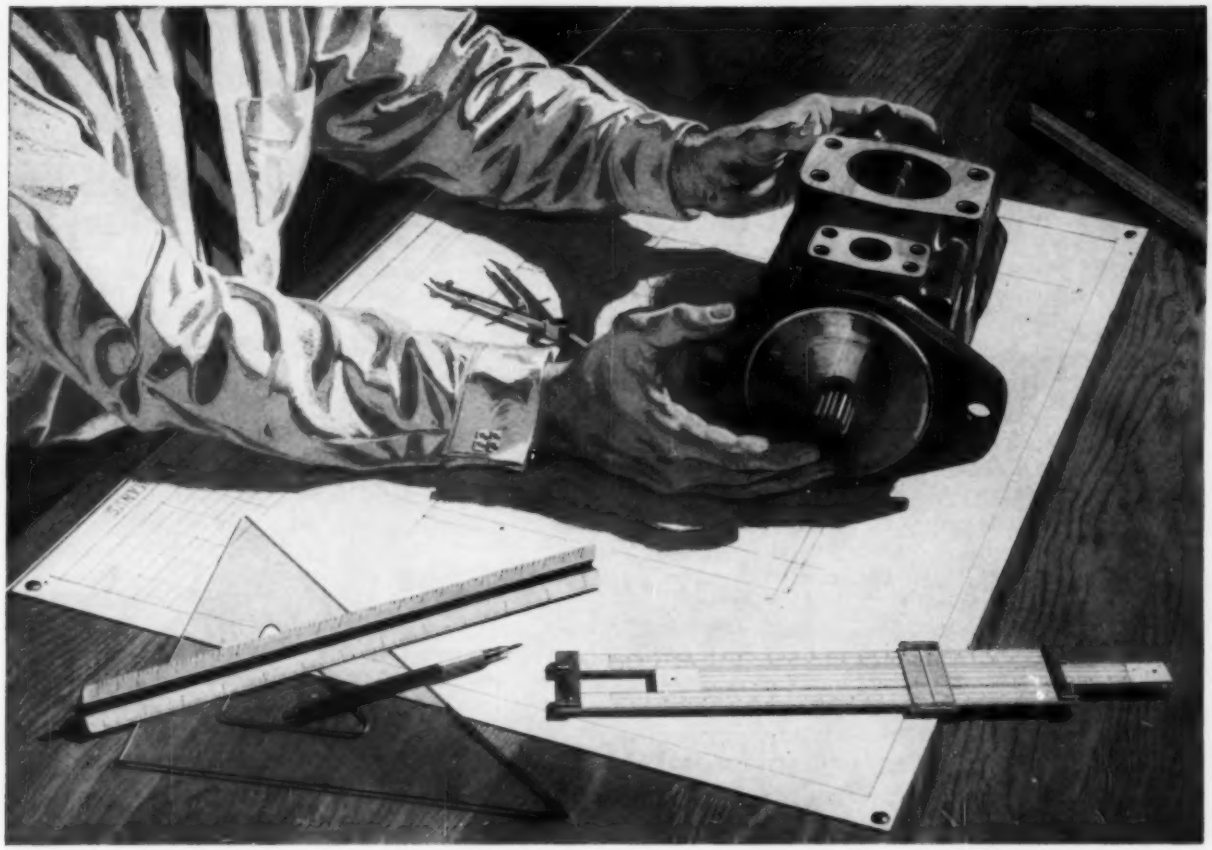
A position indicator rod, connected to the piston, interlocks a limit switch with the pump motor starter circuit, so that the valve must close before the motor shuts off. This insures water pressure to close the valve. As the NORMAL valve is de-energized, water pressure is applied through the valve to the top of the piston in the main water valve. Since the area at the top of the piston is twice that at the bottom, the piston is forced down and the valve closes. Its speed is controlled by flow control valves.

• **Emergency Operation**—Should power fail, the motor starter circuit and the solenoids of both valves are de-energized simultaneously. The normally open solenoid valve in the emergency circuit actuates the pilot valve which also ports water to the top of the piston of the main water valve. With water flowing through both the NORMAL and the EMERGENCY valves, emergency closing is faster than during normal closing speed. A needle valve in the EMERGENCY valve inlet line helps adjust the emergency closing speed. Emergency closing takes place in case of under-voltage or motor overload, or when the emergency stop switch is tripped. The emergency solenoid is connected to a limit switch which may be actuated by a pressure switch or a time-delay pilot.

After emergency closing, the NORMAL valve is opened with a handle. This handle can be locked

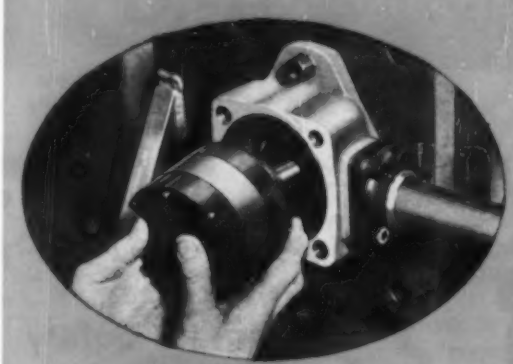
Continued on page 38





IF YOU BUILD MOBILE EQUIPMENT...

VICKERS WILL MATCH A PUMP TO YOUR APPLICATION



10 minute field repair

Typical of the advanced design features available on Vickers pumps is the replaceable pumping cartridge in the "High Performance" series. A complete overhaul: cover removal, cartridge replacement, and cover replacement takes just 10 minutes in the field—no critical fitting or adjusting!

Customized designs or standard models—both are available from Vickers. Industry's broadest line of mobile pumps allows you to select the design that's best for you . . . saves you from paying for "too much" pump and from getting "too little".

Our application engineers can help you match your specifications with one of several thousand standard combinations of single or double pumps with choices of shafts, mountings, port connections, deliveries and direction of rotation. However, when unusual requirements demand special approaches, Vickers unequaled Research and Development facilities are at your service.

Whichever type of pump you select, wherever your equipment goes, there is the additional advantage of complete interchangeability of parts built in any Vickers plant located throughout the free world, providing full service coverage.

Additional data on pumps for mobile applications is available from your Vickers application engineer or by writing to address below. Ask for Bulletin P1.

VICKERS®

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Mobile Hydraulics Division
ADMINISTRATIVE AND ENGINEERING CENTER
DETROIT 32, MICHIGAN

9461

"Thousands of 'O' rings used without known failure in the field"

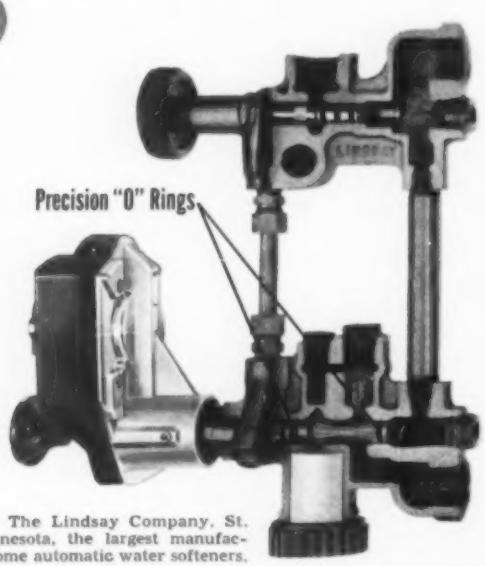
(Another manufacturer knows there's no substitute for reliability.)

"O" Ring Compound No. 1218 was developed by Precision for a leading manufacturer* of automatic water softeners.

The success of the "O" ring in service was predetermined by exhaustive Precision development research which included testing against water samples obtained from all parts of the country. "O" Rings from Compound 1218 are now giving reliable service as seals in Diesel and Aeromatic fuels, high performance gas and permanent anti-freeze.

You can be sure of having the *right* "O" ring, made from the *right* compound for your product when you come to Precision. Why not ask for the services of a Precision Engineer today?

Specify Precision—First in quality



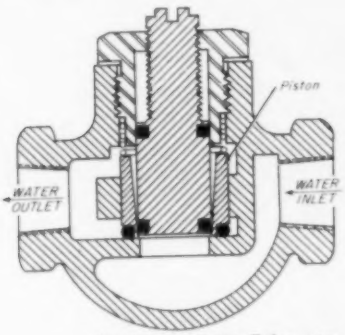
*Made for The Lindsay Company, St. Paul, Minnesota, the largest manufacturer of home automatic water softeners.

Precision Rubber Products Corporation • "O" Ring and Dyna-seal Specialist

Dept. 1, Oakridge Drive, Dayton 17, Ohio Canadian plant at: Ste. Thérèse de Blainville, Québec

Circle 118 on Reader Service Card

closed to hold the main valve open as long as necessary. When the handle is released, the main valve closes.



Courtesy Aircmatic Valve, Inc.

• **How the Flow Control Valve Works**—The rate at which the main valve opens or closes is important to prevent surges. The flow control valve has a tapered, cylindrical metering stem larger than the inlet and outlet ports. This stem construction has more orifice area than a needle valve and eliminates much of the usual pressure losses. The large annular orifice allows fine flow adjustments which can be maintained regardless of pressure changes. During reverse flow, when the valve is being closed, the piston moves off its seat, and the fluid passes freely through the flow control valve. An O-ring and a bevel seat seal the valve.

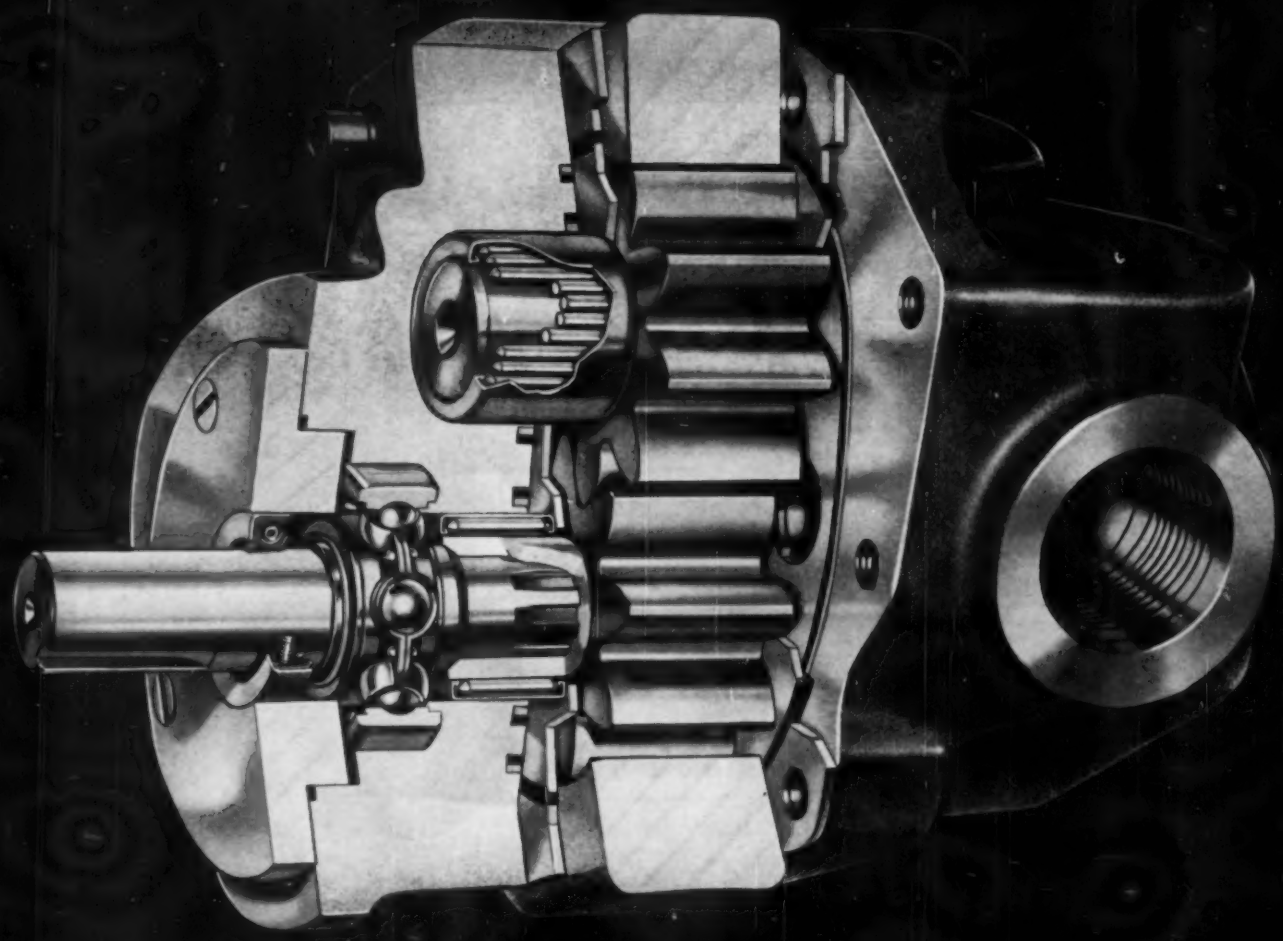
Information for this article was supplied by CLARK W. MCKEE, *Sales Engineer, Pittsburgh Controls, Inc., Pittsburgh.*

Hydraulic Press Has Built-In Safety Features

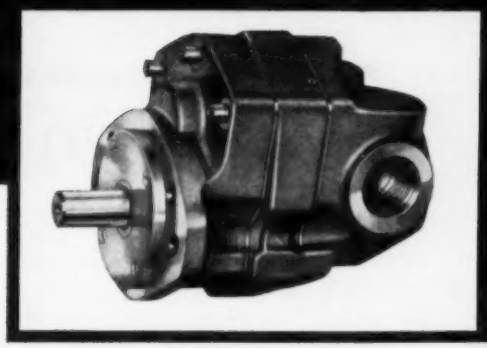
A 350-ton downward-acting hydraulic press, manufactured by the Hydraulic Press Mfg. Co., Mount Gilead, Ohio, was designed and built especially for the "gunk" process in molding reinforced plastics. The press is semi-automatic, has fast closing and automatic slow-downs, and the ac-

Continued on page 42

Circle 152



POWER *for the biggest mobile rigs, toughest jobs!*



WEBSTER "JD" SERIES HYDRAULIC PUMP

Match your big equipment to the most rugged duty with this newest Webster and you come up with some interesting answers in hydraulic performance. Fluid power up to 2000 psi! Requires less input horsepower! Saves fuel!

This sectioned view and the specifications at right tell the story. The "JD" Series' anti-friction bearings save power, pressure balanced wear plates assure high volumetric efficiency — other equally important features mean extra work output, trouble-free operation!

Webster Electric "JD" Series Pump is a trim, *very compact* unit designed to fit in tight locations. Ideal for agricultural, construction, industrial, utility equipment — machine tools as well. It's available in 5 sizes from 5 to 17 gpm — attaches easily with a choice of mountings. Ask your Webster Electric representative for all the facts on this powerful new pump — or write direct for engineering detailed sheet HYI-2.

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

RACINE · WIS

SPECIFICATIONS

Capacity: 5 sizes, 5 to 17 gpm.

Operating Pressure: Up to 2000 psi.

Operating Speed: Up to 2400 rpm.

Wear Plates: Pressure balanced — prevent clearance changes from heat.

Bearings: 4 anti-friction needle bearings — save power or fuel. Ball bearings on drive shaft to absorb end thrust.

Gears: Smooth-running, spur cut. One piece gear and bearing journal units assure minimum deflection and proper alignment.

Drive: Free-floating internal spline — eliminates key failures.

Seal: Double lip on drive shaft — added protection from seal failure and dirt.

Porting: End, side, or bottom.

Mounting: SAE Type A, 2-bolt mounting flange standard. Foot mounting optional.

FOR HIGH-TEMPERATURE, HIGH-PRESSURE APPLICATION...

NEW 2 AND 3-WAY CECO VALVES ARE READILY ADAPTABLE TO YOUR REQUIREMENTS!

Fabricated without organic materials, the carbon steel valves pictured here represent a new Chandler Evans valve design which lends itself to a variety of special-purpose applications.

Requirements on this particular assignment were for valves to provide flow of demineralized water up to 400 gpm at temperatures to 600°F. and pressures to 2000 psig, with minimum maintenance for 25-year service. An air-operated actuator is an integral part of each assembly, and an air-supply system and remote control panel complete the package.

Development of valves in this series was facilitated by CECO's high-temperature test loop. CECO engineers accented flexibility in design. The valves can be scaled up or down to suit other flow, temperature or pressure requirements. They can be fabricated from materials compatible with corrosive fluids. They are ideal for remote control installation, using manually or electrically operated selector valves. Pneumatically actuated in present form, they can be adapted for mechanical, hydraulic or electrical actuation.

To discuss your requirements, contact Mr. Harold E. Francis, Nuclear and Industrial Products Manager.

CHANDLER EVANS CORPORATION West Hartford 1, Connecticut

A SUBSIDIARY OF FAIRBANKS WHITNEY CORP.

CECO SYSTEMS CONTROLS

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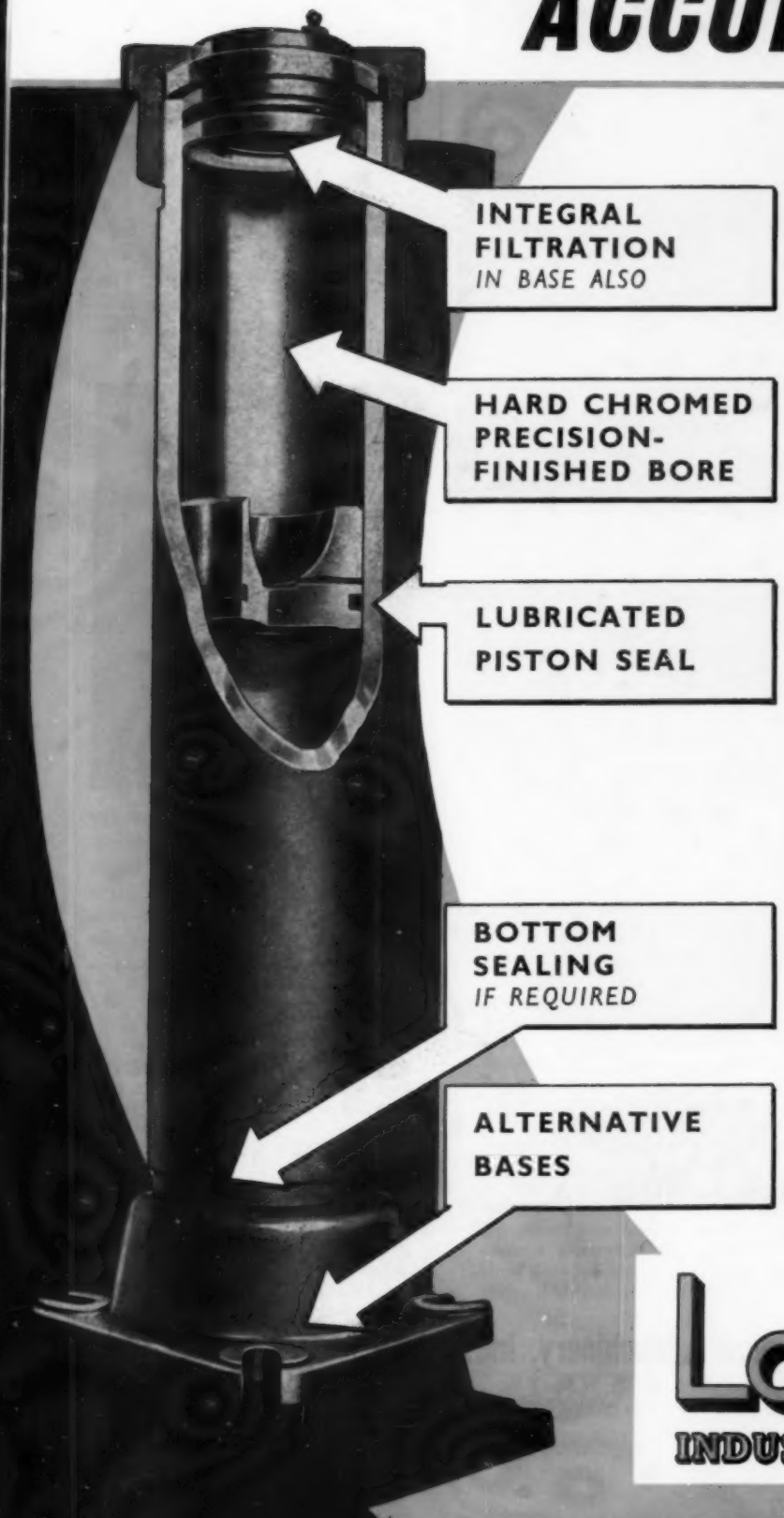
Circle 90 ➡

LOCKHEED HYDRAULIC ACCUMULATORS



Incorporating many valuable features, these piston-separator type accumulators are available in capacities from ¼ gallon to 12 gallons and are suitable for working pressures up to 3,000 p.s.i.

USE THEM . . .

- ★ to supplement pump in satisfying widely fluctuating power demands
- ★ to store power for infrequent or emergency operation of cylinders, etc.
- ★ to provide sustained effort
- ★ to afford rapid 'approach' stroke avoiding use of pump with dual delivery rates
- ★ to absorb fluid displaced by mechanical shock.

LOCKHEED PRECISION PRODUCTS LIMITED
INDUSTRIAL HYDRAULICS DIVISION
SHAW ROAD, SPEKE, LIVERPOOL 24, ENGLAND
Telephone: Hunts Cross 2121
Telex: 62394

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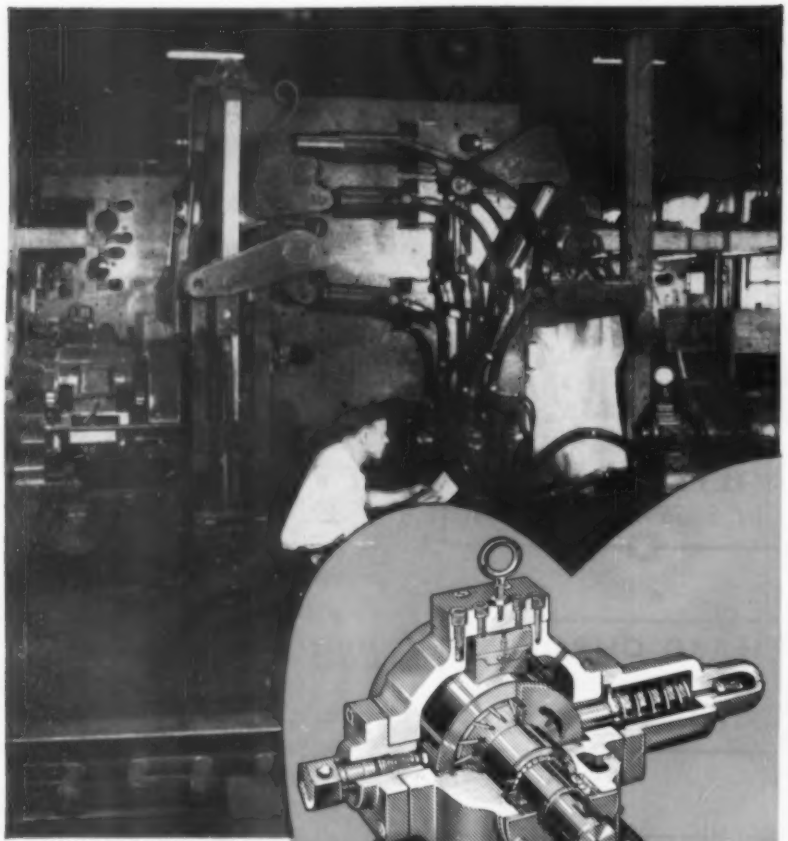
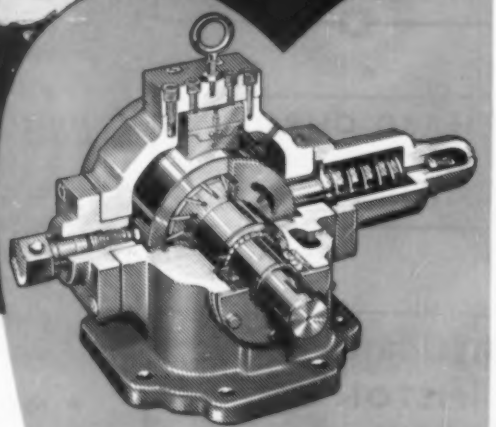


SUPER TRUSTEE CONCRETE BLOCK MACHINE BUILT BY THE GENE OLSEN CORP., ADRIAN, MICHIGAN



The heart of this 1100 blocks per hour concrete block machine is a RACINE MODEL 8R PUMP

This dependable hydraulic heart

REDUCES UPKEEP AND DOWN-TIME BY AS MUCH AS 80%

"RACINE HYDRAULIC EQUIPMENT is the *heart* of our concrete block machines," says C. S. DeLamater, sales manager for The Gene Olsen Corp., another satisfied user of RACINE PUMPS and VALVES exclusively since 1949. Besides the tremendous savings in operating hydraulically-designed concrete block machinery, the firm emphasizes the advantage of simplified control of oil circulation in RACINE VARIABLE VOLUME PUMPS. They pump *only* the oil required to do the job — no waste of pressure oil — no heating. Thus through lower horsepower, operation economies are enjoyed.

RACINE

Racine Hydraulics & Machinery, Inc.

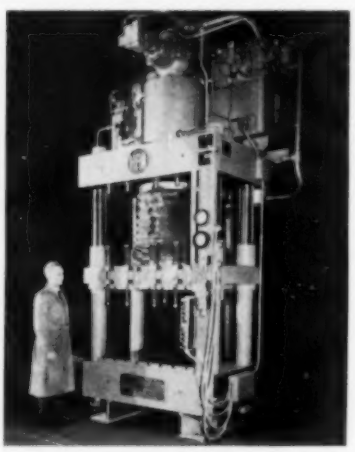
RACINE, WISCONSIN

HYDRAULICS DIVISION

Circle **121** on Reader Service Card

curate speed and pressure controls necessary in this molding process.

For safe operation, the moving platen is locked hydraulically and will not drop at the end of the automatic cycle or while the selector switch is on manual control. Nor will it drop when the up-and-down pushbutton is not depressed, in case of power failure, or when the shut-off safety stop pushbutton is depressed. The lower limit of ram travel is protected by a stop built into the ram and cylinder assembly.



All valves, except the surge valve, are mounted on a panel at the head of the press. This keeps piping at a minimum and gives easy access. A bellows type, ram boot, with breather protects the hydraulic cylinder from contamination.

Classes in Elementary, Advanced Hydraulics

The Fluid Power Institute, in cooperation with the Milwaukee School of Engineering has started a six-course program in hydraulics at MSOE.

The curriculum consists of two parts. The elementary course is designed for those who want an introduction to the fundamentals of hydraulics, and will consist of

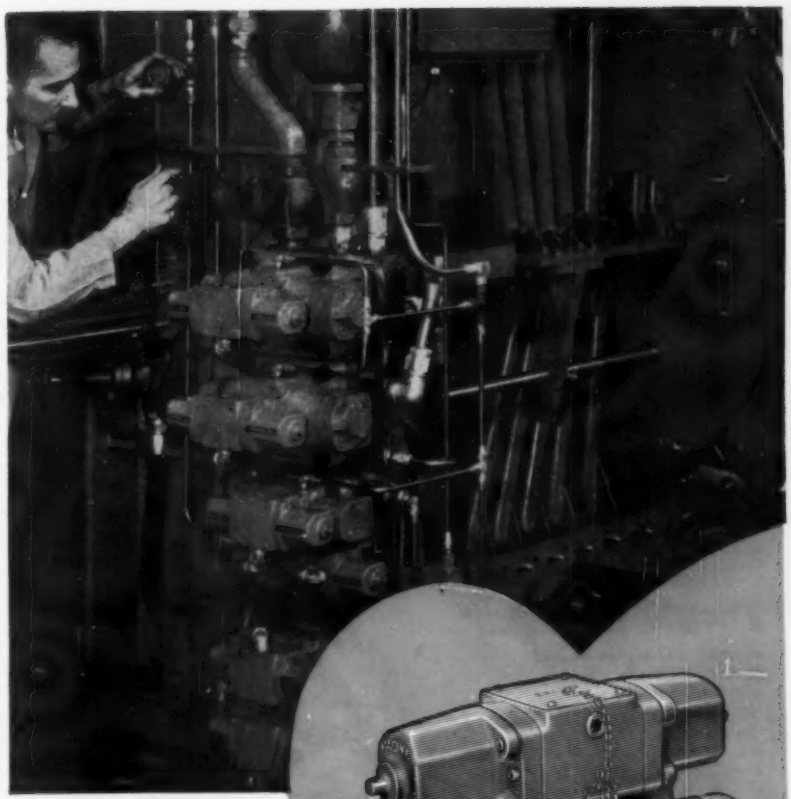
two classes: an introduction to hydraulics, and a course on the maintenance of fluid power components.

The advanced course will start with the same introductory course, but will continue with basic hydraulics, mathematics of fluid power, advanced hydraulics, and advanced circuits.

The FPI hopes to move all classes from their present evening school scheduling to MSOE's regular day-school curriculum. Instructors will be hydraulic engineers from the Milwaukee area industries. Teaching materials will include slide presentations, cutaway models contributed by hydraulic component manufacturers, laboratory demonstrations, and other visual aids.

In addition to this educational venture, the Institute hopes to build a hydraulic laboratory which will serve a dual purpose. It will be the demonstration lab for the above fluid power classes and will accept contract test and research projects for hydraulic manufacturers, component users, and firms with fluid power problems. Another area of interest could be jointly sponsored basic research. ▼▼▼

SIX AIR POWERED SPINDLES are provided on this turret drill, manufactured by Burgmaster Corp., Gardena, Calif. Feed rate is adjustable to include rapid traverse in both directions from the cut. For manual setting of a series of holes, the positioning table has an air-operated shot pin to engage a template that moves with the work and keeps the hole center distances constant. In semi-automatic operations, the turret cycles through a sequence of operations, including skip index for idle stations, and stop for the load function. Fully automatic operation cycles the machine with the controls synchronized to air shuttle tables, air index tables, air blasts, and hopper feeds.

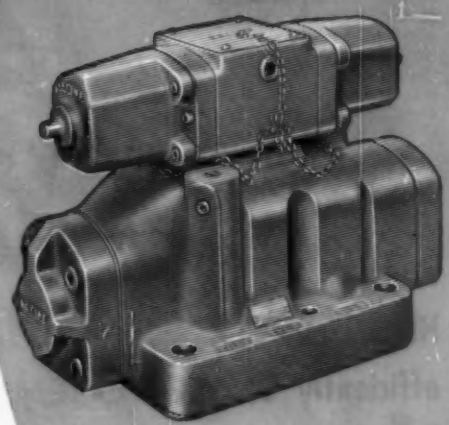


HYDRAULIC VALVE SYSTEM OF WIRE-FORMING MACHINE BUILT BY RESEARCH DESIGNING SERVICE, INC., CENTERLINE, MICHIGAN

during set-up and at 3000 springs per hour

RELIABLE VALVES DIRECT THE POWER OF A HYDRAULIC HEART

"Control of all our hydraulic operations is vital, and this is possible with RACINE equipment," says Bill Karolle, electrical engineer with Research Designing Service, Inc. "Our hydraulic machines are used to form wire for 80% of all automobile seat springs." As oil requirements change constantly during set-up operations, 6 RACINE DIRECTIONAL CONTROL VALVES guide the *right oil volume* at the *right pressure* to the *right place* at the *right time*. At high production speeds, these 4-way, solenoid-controlled valves maintain the pre-set wire forming pattern with absolutely uniform precision. Valve reliability is important since these machines may perform over five million cycles during their lifetime.



6 RACINE

Directional Control Valves guide hydraulic wire-forming operations of this machine

RACINE

Racine Hydraulics & Machinery, Inc.

RACINE, WISCONSIN

HYDRAULICS DIVISION

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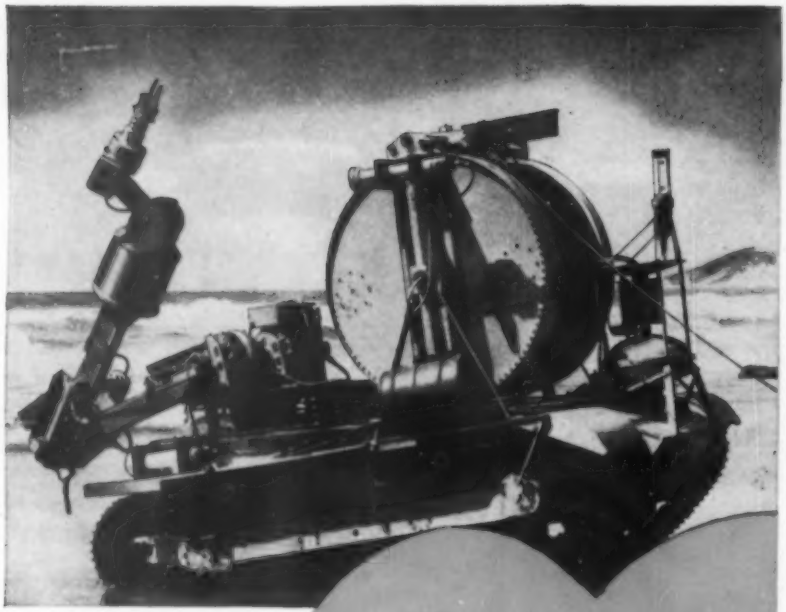
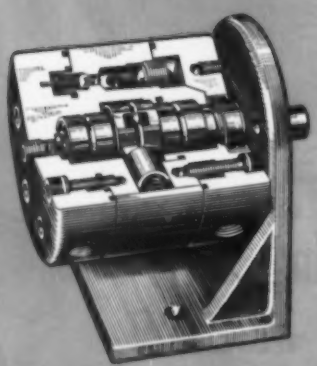


REMOTE UNDERWATER MANIPULATOR BUILT FOR THE U. S. NAVY BY THE SCRIPPS INSTITUTION OF OCEANOGRAPHY OF THE UNIVERSITY OF CALIFORNIA AND THE HUDSON LABORATORIES OF COLUMBIA UNIVERSITY.

This hardy HYDRAULIC HEART operates efficiently even 20,000 ft. under water

A RACINE pump actuates the mechanical arm on the Remote Underwater Manipulator, a new experimental vehicle the U. S. Navy uses to explore the ocean floor down to depths of 20,000 ft. The arm makes all the motions of the human arm and hand. It picks up samples from the ocean floor . . . assembles and installs instruments in the ocean depth. Land-based remote controls operate the underwater explorer. Rated at 1,000 psi continuous pressure, the RACINE pump automatically compensates for the compressibility of oil under various sea water pressures. When you need *versatile* hydraulic components — sturdy and dependable for *any* use from research to assembly line — your best choice is RACINE!



The Heart of this Exotic Ocean Explorer Is a RACINE

MODEL D5 PUMP

RACINE

Racine Hydraulics & Machinery, Inc.

RACINE, WISCONSIN

HYDRAULICS DIVISION

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FUTURE EVENTS

SAE AEROSPACE ENGINEERING & MANUFACTURING MEETING

October 9-13

The Ambassador
Los Angeles

AMERICAN ROCKET SOCIETY 16TH ANNUAL MEETING & SPACE FLIGHT REPORT TO THE NATION

October 9-15

New York Coliseum

ASA 12th NATIONAL CONFERENCE ON STANDARDS

October 10-12

Rice Hotel
Houston

AIEE 12th MACHINE TOOLS INDUSTRY CONFERENCE

October 16-18

Faust Hotel
Rockford, Illinois

ASME-ASLE JOINT LUBRICATION CONFERENCE

October 17-19

Morrison Hotel
Chicago

FLUID POWER SOCIETY ANNUAL MEETING

October 18

Sherman Hotel
Chicago

NATIONAL CONFERENCE ON INDUSTRIAL HYDRAULICS

October 19-20

Sherman Hotel
Chicago

43RD NATIONAL METAL EXPOSITION & CONGRESS

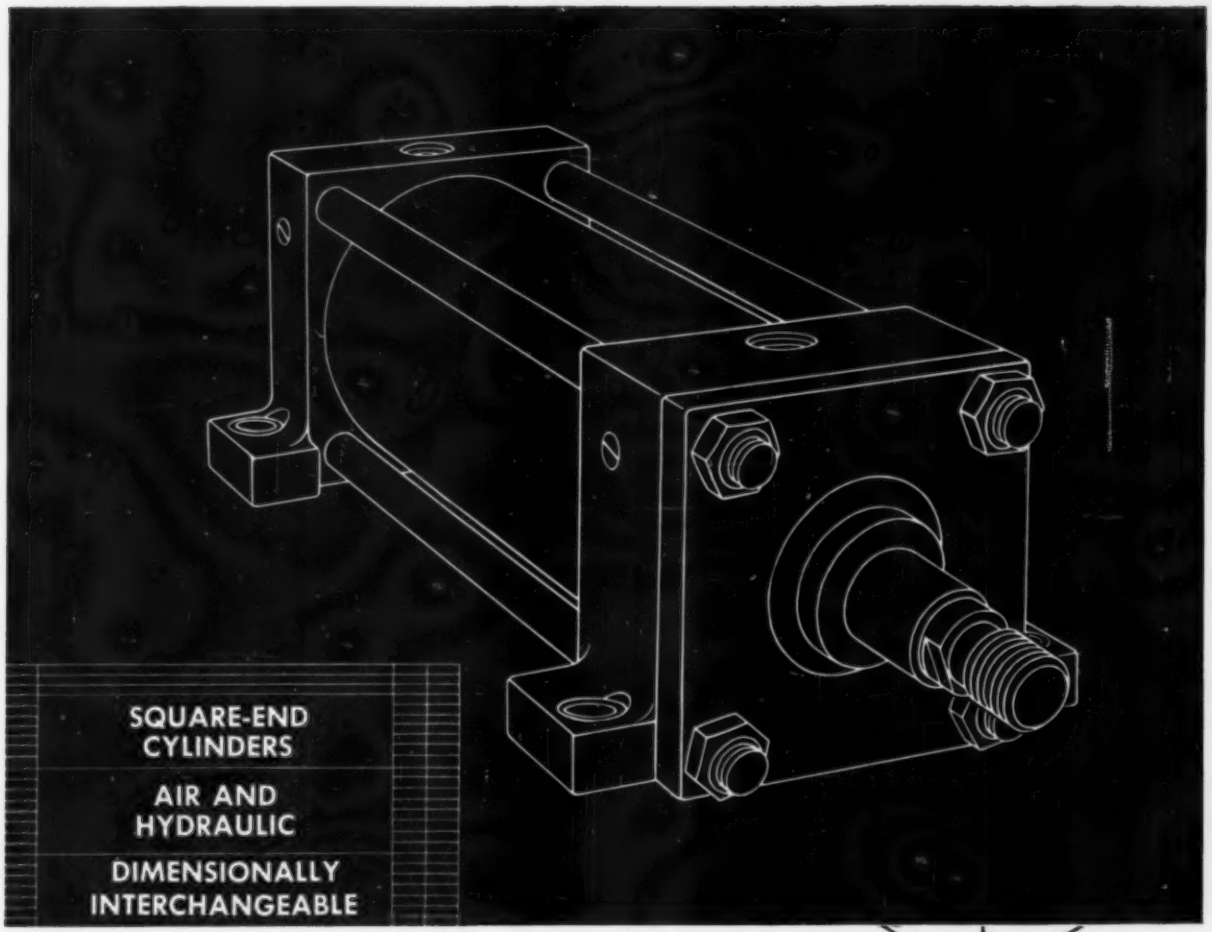
October 23-27

Convention & Exhibits Bldg.
Detroit

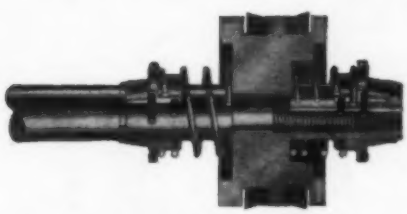
NFPA FALL MEETING

October 24-26

Sheraton Hotel
Philadelphia



How MEAD takes the BUMP out of high-speed pistons



FULL FLOATING CUSHIONS

Detail shows two-stage feature of full floating cushion on a piston used for hydraulic pressures over 250 psi. MEAD Square-End Cylinders also offer these other design advantages:

- Seamless, hard drawn, micro-finish brass barrel for long piston seal life
- Cold drawn steel cylinder heads with all surfaces permeated with black oxide for rust resistance
- High tensile chrome plated steel piston rods
- Accurately machined rod bearing cartridge made of solid bearing bronze

Special *full floating cushions* in new MEAD Square-End Cylinders are uniquely mounted on springs rather than on solid studs. The result is a smooth, high-speed piston advance without the use of ball checks. In hydraulic units, the two-stage design of the floating cushions completely eliminates bumping. Fully adjustable from the slightest measurable cushioning effect to complete stoppage, the full floating feature also reduces cushion wear caused by impurities in the working medium. In air models up to 250 PSI and hydraulic units up to 1000 PSI, MEAD Square-End Cylinders are available in a full range of bore, stroke and piston sizes. Complete selection of mounting styles. All units are dimensionally interchangeable and conform to JIC specifications. For consultation and information on quick delivery and competitive prices, write to MEAD *today*.

PRODUCTS FOR AUTOMATION

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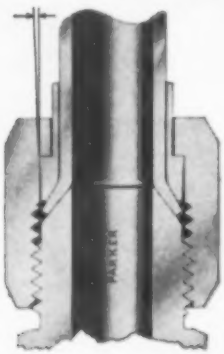
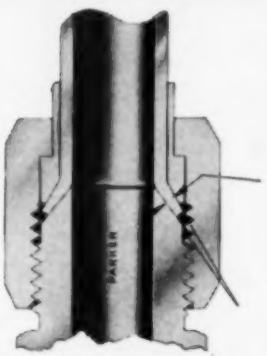
ASK YOUR MEAD MAN about 24-hour service on most MEAD products . . . 48 hours on special orders.

PARKER "TRIPLE-LOK®" 37° FLARE FITTINGS GIVE YOU THE QUALITY YOU NEED AT EVERY CRITICAL POINT!!!



A tiny Reverse Clearance Angle makes the Parker sleeve act as a lockwasher. Sleeve shoulder exerts pressure back against nut to prevent loosening from vibration, or from expansion and contraction.



The precise Differential Angle between sleeve and nose gives you perfect surface contact, maximum sealing and even distribution of make-up loads. It compensates for natural thinning of the flare.

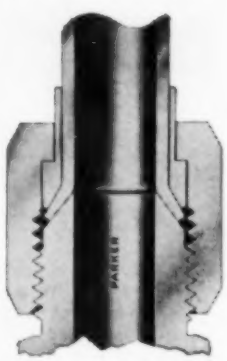
PARKER WORKMANSHIP PAYS OFF FOR YOU IN ASSEMBLY AND USE

The fact that Parker developed the original 37° flare fitting is only part of the story. At Parker today, infinite attention to detail is your assurance that you will get all the plus values inherent in the original Parker design.

Illustrated here are only four of the many critical points which Parker watches in making "Triple-lok," the 37° flare fittings that bear the Parker name. Tiny variations from the angles and clearances to which Parker craftsmen work can mean the difference between the maximum protection you get from the Parker product and something much less dependable. A Parker-Hannifin distributor is as near you as your telephone. Check the Yellow Pages, or write us direct.

Fittings shapes are machined from high-strength, one-piece forgings. No cast, extruded or brazed construction. The finer grain structure of forgings provides higher tensile strength and a greater elongation factor.

"Triple-lok" parts can be used repeatedly . . . are never deformed in make-up nor wedged on to tubing. Sleeve never rotates during assembly . . . no danger of wiping or scoring tube flare.



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PARKER HANNIFIN CORPORATION

PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

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Circle 99 →

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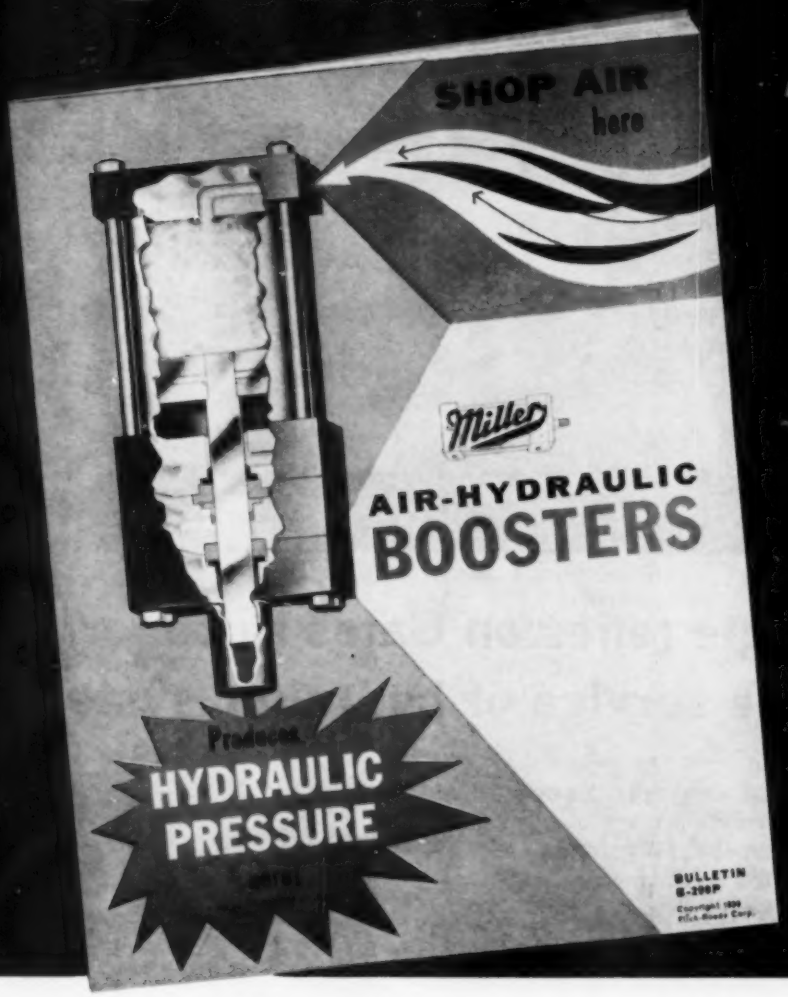

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You can use Boosters to particular advantage in:

Pressing	Stamping
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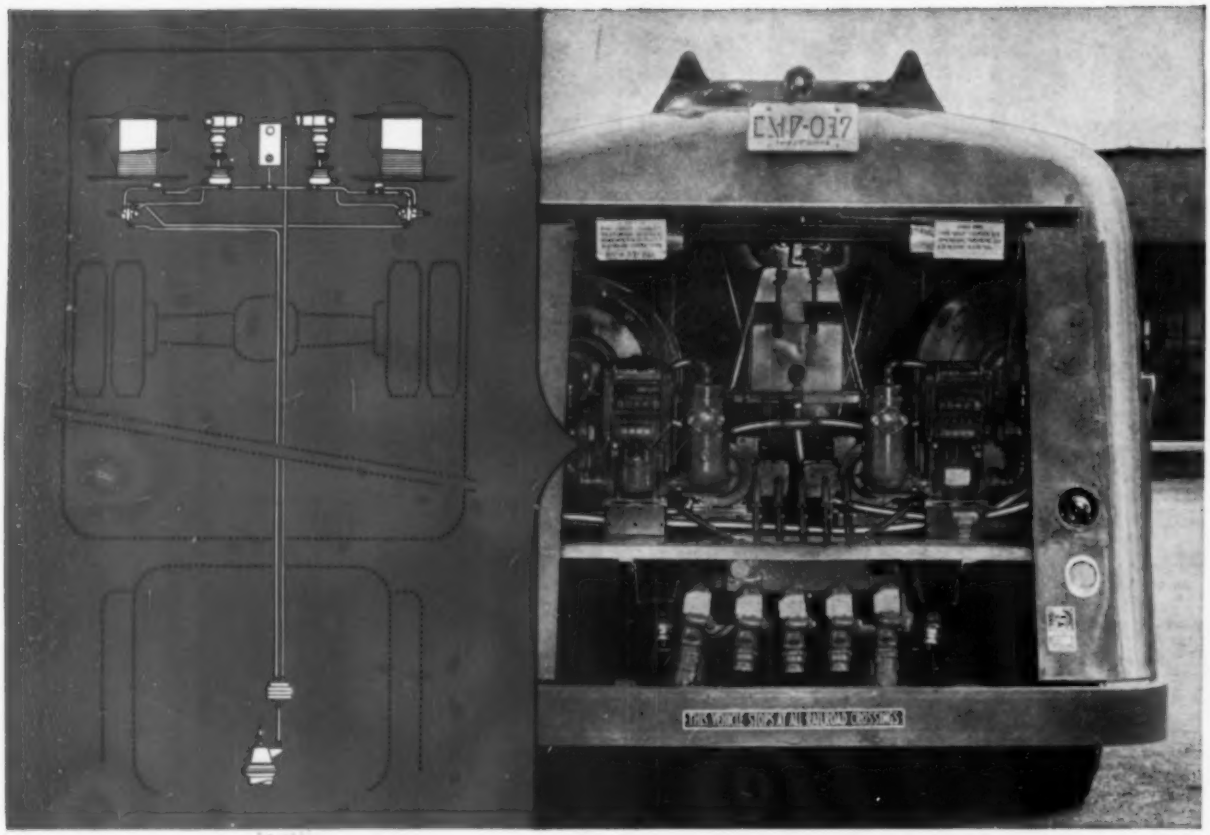
AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS



Ardmore Products relies on Gates Hose for long, dependable service of hydraulic systems

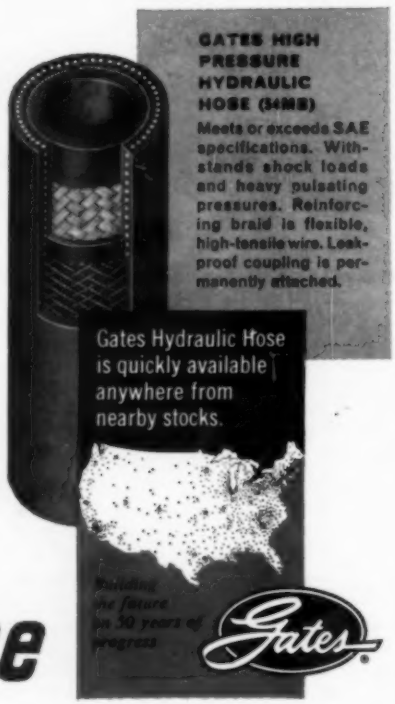
Gates Hydraulic Hose is standard equipment on hydraulic systems made by Ardmore Products, Northbrook, Illinois. These systems are used on tank trucks for pumping petroleum products and for power drives for hose reels.

The Ardmore Hydraulic Drive System is considered explosion-proof . . . is easy to install . . . and is virtually maintenance-free. All connections are made with Gates Hydraulic Hose.

Mr. Edward J. Doyle, Jr., Ardmore General Manager, says, "We use Gates hose to assure the dependability and quality of our product. Furthermore, Gates offers the best in service and in technical assistance."

Ask for Gates technical aid in designing hydraulic systems.

The Gates Fieldman located near you is a fully-qualified hydraulic hose expert. He can give you valuable assistance in designing hydraulic hose systems. Ask him for Gates Hydraulic Hose Assemblies booklet, IH43.


GATES HIGH PRESSURE HYDRAULIC HOSE (34MB)
Meets or exceeds SAE specifications. Withstands shock loads and heavy pulsating pressures. Reinforcing braid is flexible, high-tensile wire. Leak-proof coupling is permanently attached.
Gates Hydraulic Hose is quickly available anywhere from nearby stocks.
Gates

The Gates Rubber Company, Denver, Colorado

BP 52

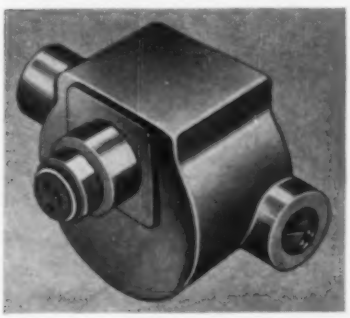
Gates Hydraulic Hose

NEW PRODUCTS

Circle the numbers on the Reader Service post card for more information

ROTARY PRESSURE SWITCH

Converts fluid pressure to electrical output, for warning or control. Rotary action of cam converter as-



sembly triggers microswitch; also permits ganging of up to four switches. High reliability and long life—500,000 cycles minimum.

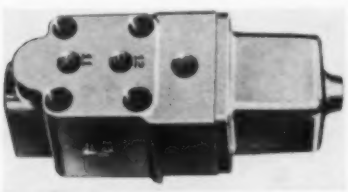
Specifications: Actuates under pressures of 6 to 600 psig, and operates to pressures of 3000 psig. Standard ratings, 5 amps resistive, 3 amps inductive at 30 VDC and 5 amps at 125/250 vac. Available in aluminum, magnesium or stainless steel housings.

Designation: Series RPS 17.—*IMC Magnetics Corp., Phoenix.*

Circle **300** on Reader Service Card

PILOT VALVES

Solenoid-operated valves have built in check and adjustable choke for free flow-out operator port and restricted flow-in operation port.



NO and NC three-way plungers and auxiliary operator port for parallel operation of other components. Used as standard operators on Oilgear two-, three-, and four-way directional control valves, foot valves, and surge valves.

Specifications: All sizes have ¾ pipe taps for pressures to 3000 psi. Direct solenoid-operated, spring returned plungers. Flow areas equivalent to ¾ dia. Overall dimensions are 11" x 4" x 4".—*The Oilgear Co., Milwaukee, Wisc.*

Circle **301** on Reader Service Card

CONTROL & LINE VALVES

Spanseal control valves consist of basic valve, manifold block, and operating attachments. They are available in 4, 3, and 2-way, diverter and shuttle cycles. The line valve is a uni-directional shut-off unit with an integral actuator. It

is available in a straight shut-off cycle or as a shut-off valve with downstream vent.

Specifications: Control valves available for 1500-psi pneumatic and hydraulic service, −40°F to +250 F. Line valves available for 1200-psi air and oil service (2400-lb. test) and −40°F to +250°F. —*Ledeen Inc., El Monte, Calif.*

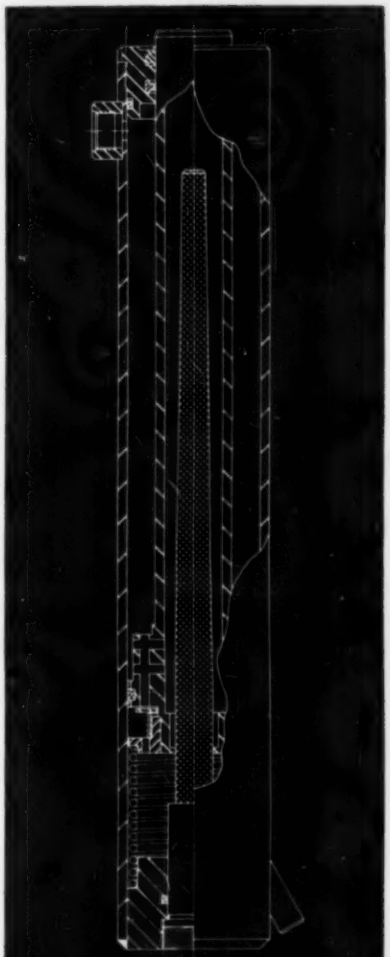
Circle **302** on Reader Service Card

PNEUMATIC VALVE ACTUATOR

Remotely controlled, pneumatic valve actuator can be installed on quarter-turn valves of any type, make, or size. Easily assembled to the valve because the bolts and stem adaptor of the actuator are made for the valve it will be in-

Continued on next page

IMAGINATION FOR SALE!



ENERGY ABSORBER

Delicate equipment is cushioned to a stop in less than half a second with this UH-designed hydraulic deceleration cylinder. Exerting 11,600 pounds of force, the UH cylinder decelerates and stops a large mass of instrumentation in .43 seconds in 19" of travel.

Whether your hydraulic problem is deceleration or acceleration . . . prototype or production run . . . complex or commonplace, call or write us today. Creative engineering by Universal Hydraulics costs nothing extra—but it pays.

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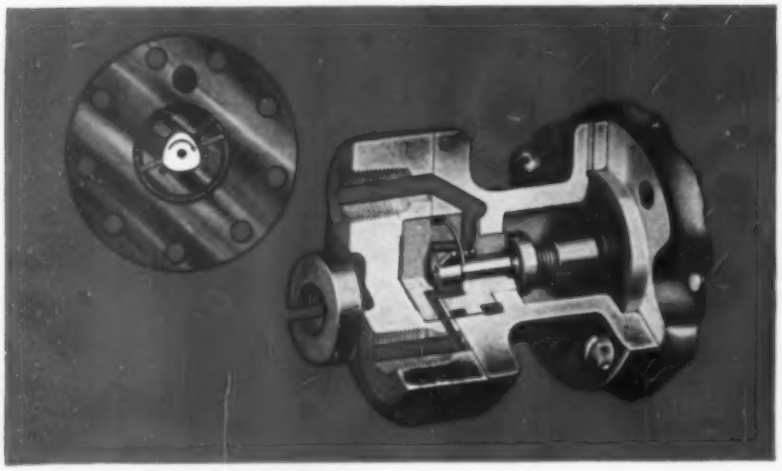
Circle **146** on Reader Service Card

YESTERDAY'S PIONEER . . . TODAY'S LEADER

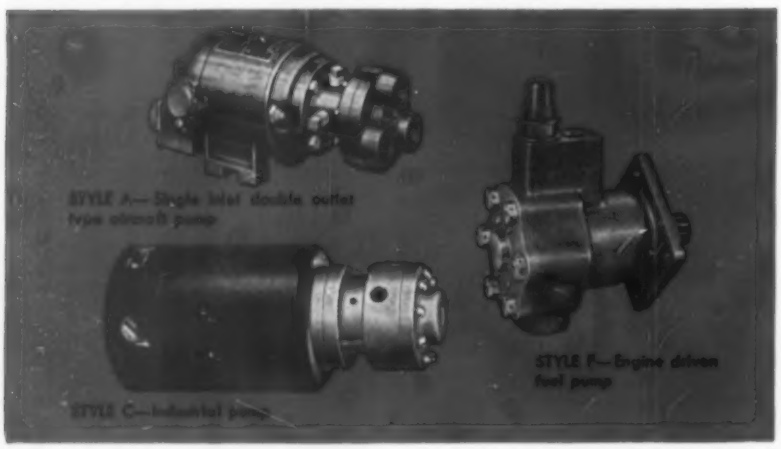
WELDON / FLUID METERING PUMPS

Positive Displacement Rotor Type. For Industrial Applications, Aircraft Anti-Icing and Aircraft Fuel.



IT'S SO SIMPLE!

The rotation of the rotor draws the fluid in through two passages, filling the cavities formed by the three lobes of the rotor. This fluid is sealed within these small cavities until it is forced through the two outlet holes by the floating blades. The flow may be kept uniformly divided through two outlet ports, or may be combined internally for passage through a single port.



COMPACT • LIGHT WEIGHT

Send for Weldon Manual and Catalog with detailed specifications and installation drawings, covering the full range of Weldon pumps in various capacities. Specify your requirements.

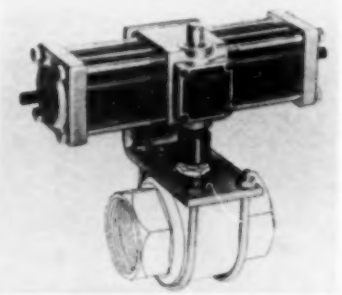
THE WELDON TOOL COMPANY

3000 WOODHILL ROAD · · · CLEVELAND 4, OHIO

Circle **153** on Reader Service Card

NEW PRODUCTS

stalled on. No special tools needed. Lubricated and sealed at the factory. Self-contained, with no external levers or swiveling cylinders. Nylock set screws allow adjustment of actuator's full open and closed position to compensate for valve's wear and backlash.

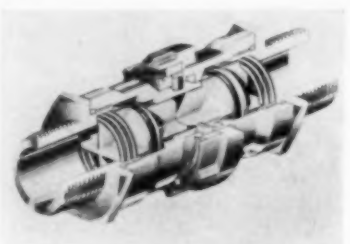


Specifications: Four models: 100, 260, 825, and 2050 in.-lb. of torque.—*Contromatics Corporation, Rockville, Conn.*

Circle **303** on Reader Service Card

HIGH PRESSURE COUPLING

Heavy duty, high pressure, compact, industrial quick-connect coupling has positive valve action, faster locking, and longer seal life. Star-shaped valves allow free flow which reduces pressure drop across the coupling. Locking cams provide fast, direct locking. Only a quick, rotary twist is required. Springs are not used. Balanced locking-load distribution virtually eliminates brinelling. Simplified sealing mechanism provides uniform squeeze, so O-rings seal equally well against high pressures or vacuums.



Specifications: Available from ¼" through 3" with IPT, MPT, and for commercial hose fittings. For petroleum, hydraulic, and synthetic fluids and oils; acids, air, and wa-

ter. Materials are steel, brass, bronze, and stainless steel. For a 1" steel coupling with standard seals, the ratings are: proof pressure, 5000 psi; burst pressure, 7500 psi; temperature, −40 F to 250 F; pressure drop is 7.2 psi at 30 gpm.

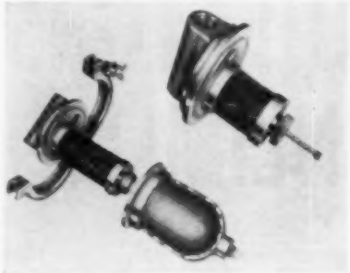
Designation: Roto Lock Industrial. *—Jack & Heintz Div., The Siegler Corporation, Cleveland.*

Circle **304** on Reader Service Card

COMPRESSION SPRING FILTER

Permanent, compression spring filter consists of two, interwound springs, one wire coiled around the other. Advantages of spring construction are precision spacing, easy spring-apart cleaning with automatic return to the original filter pattern, and filtering of large volumes of high viscosity liquids. Snapped apart for cleaning without removing from the line. May be ganged for higher capacity.

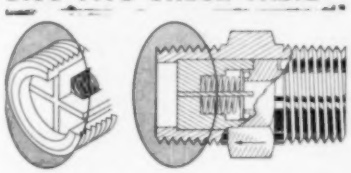
Specifications: Made of aluminum and stainless steel, or all stainless for corrosive liquids. Models for pressurized pipelines, suction tubes, and immersion pumps. Performs at differential pressures exceeding 100 psi. Elements available for filtering comparable to 20, 40, 60, or 100 mesh screens. Medium pressure



model shown will handle 1000 psi. *—The Chrom-O-Lite Co., Minneapolis.*

Circle **305** on Reader Service Card

DISC TYPE CHECK VALVE



Disc type check valve is housed in a standard hex nipple. Because of its open construction, flow characteristics are excellent. Opening pressure is 2 psi. O-rings are Buna-N, spring and disc are stainless steel. Valves are stocked in brass in ¼", ⅜", and ½" MPT.

Designation: 1500 series.*—Bodnar and McDermott Mfg. Co., Mount Vernon, N. Y.*

Circle **306** on Reader Service Card

AIR COMPRESSOR GOVERNOR

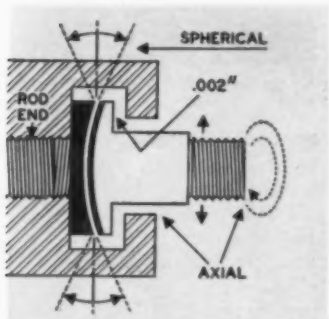
Governor for air compressor continuously maintains receiver pressure within one lb of any given setting while the compressor is in operation. With the governor, the motor load is always in direct proportion to the air demand, resulting in a lower, over-all load factor. Only one self-actuating, moving part. Requires no internal adjustments, cleaning, lubrication, or other maintenance. Is quickly installed on any compressor that uses conventional regulating equipment and unloading inlet valves. Pressure adjustment is by a simple, screw setting. Multi-stage compressors require a governor for each stage.

Continued on next page

NEW SELF-ALIGNING ROD END COUPLER

- Reduces cylinder bearing wear caused by side loads and binding
- Compensates for machinery deflection due to weight shifts
- Saves cost and time of custom-designing special assemblies
- Allows greater machinery tolerances
- Simplifies machine installation, either OEM or on the job
- Fits all air and hydraulic cylinders built to industry standards
- Male or female couplings. Female thread mates with standard style No. 2 cylinder piston rods
- Immediate delivery from stock of couplers for ⅝, 1, 1⅜, 1¾, 2, and 2½-inch diameter rods. Also available for 3, 3½, 4½, and 5½-inch rods.

Spherical movement (on push only) and axial movement provide precision alignment between cylinder and machine. Couplers shipped with .002" clearance between floating head and shoulder of retaining nut.



HYDRO-LINE

5601 PIKE ROAD, ROCKFORD, ILLINOIS manufacturers of: high- and low-pressure hydraulic cylinders • heavy-duty air cylinders • adjustable-stroke cylinders • dispensing cylinders • intensifiers • single-acting cylinders • booster cylinders

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DEPENDABILITY UNLIMITED

ACCUMULATORS UNLIMITED

Meeting engineering demands for 20 years has meant continual upgrading for the Greer Accumulator. Today's reliability, safety and service are the result of this unmatched field and operational experience. Engineering application and service are available from any of the 23 field offices, distributors or factory personnel. Bring your engineering problem on standard accumulators or special adaptations to Greer.

Friction Free Bladder Types

3000 psi, 8 sizes: 10 gal., 5 gal., 2½ gal., 1 gal., 1 qt., 1 pt., 10 cu. in., 1½ cu in. 6000 psi, 3 sizes: 10 gal., 5 gal., and 2½ gal. The only type of its design approved under ASME codes of unfired pressure vessels. Approved by Coast Guard and I. C. C. regulatory bodies. Meets J. I. C. regulations.

Floating Piston Types

3000 psi, 14 sizes: 30 gal., 25 gal., 20 gal., 15 gal., 12 gal., 10 gal., 5 gal., 4 gal., 2½ gal., and 1 gal.; 116 cu. in., 60 cu. in., 30 cu. in., and 10 cu. in.

Spherical Types

1000-3000 psi, 3 sizes: 10", 7" and 5" diameters

ASK FOR FULL ENGINEERING DATA

GREER HYDRAULICS, INC.

5930 West Jefferson Blvd., Los Angeles 16, California • UP 0-9161

Eastern Sales Engineering Office: 496 Grand Boulevard, Westbury, Long Island, N.Y. • ED 3-3700

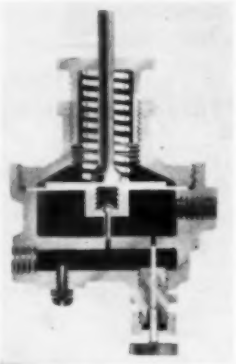
Midwest Sales Engineering Office: 7331 North Ridgeway Avenue, Skokie, Illinois • OR 5-2693

Distributors and representatives throughout the United States and Canada
Licensees in Germany, France and England

Circle **57** on Reader Service Card

NEW PRODUCTS

Specifications: Standard units for 150 psi. Higher pressures to specification.

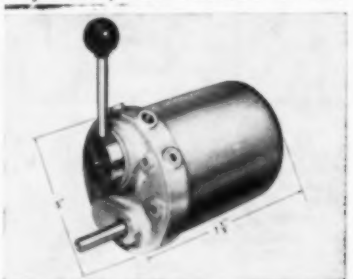


Designation: Trymatic—*Trymac, Inc., Erie, Pa.*

Circle **307** on Reader Service Card

COMPACT HYDRAULIC POWER UNIT

Completely self-contained, hydraulic power unit has a hydraulic gear pump with finger tip control, system relief valve, 4-way valve, 3-way valve, and reservoir in one



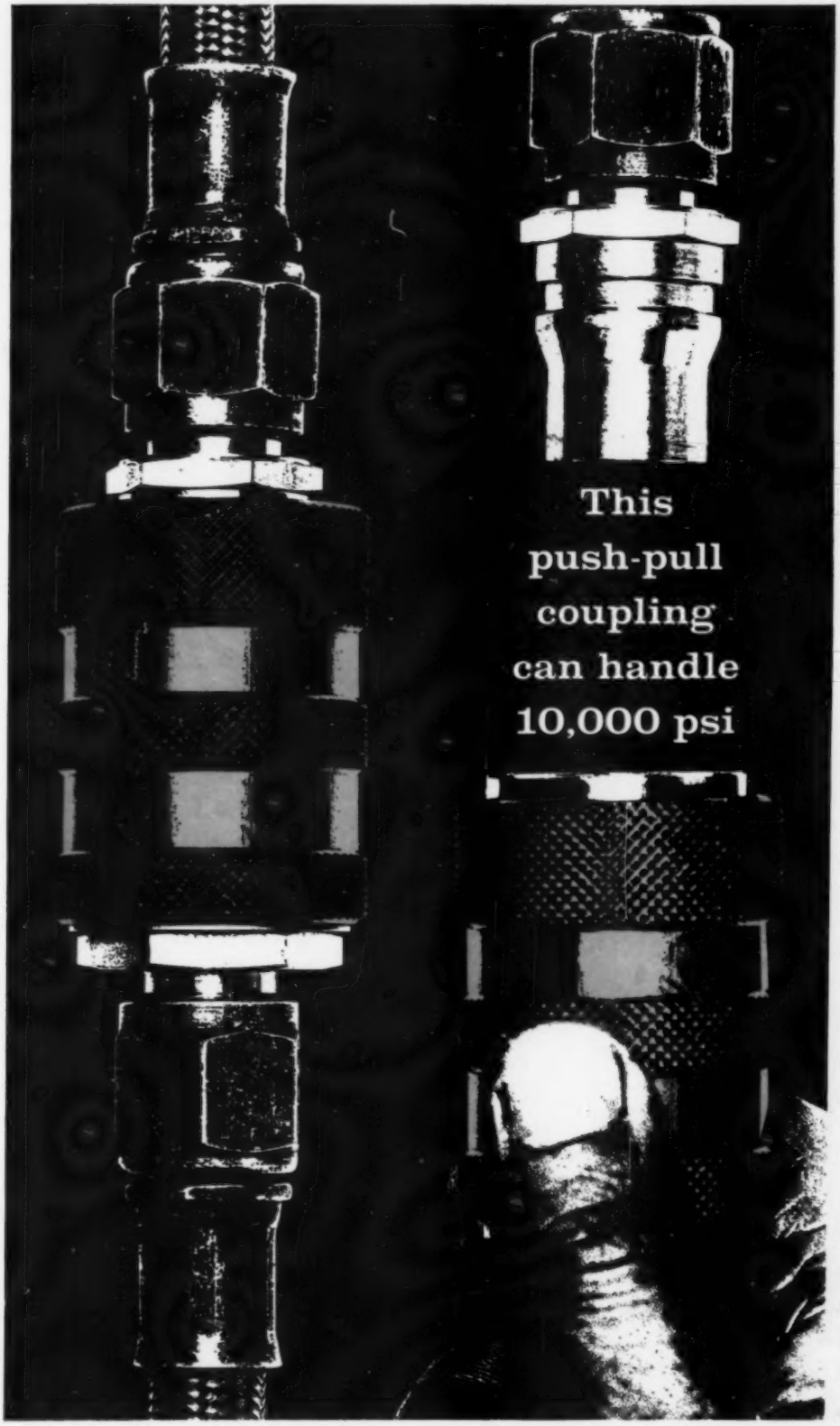
unit. It can be flange or strap mounted, and is available for either horizontal or vertical mounting.

Specifications: Pump delivers up to 2¾ gpm at up to 400 psi and 1800 rpm shaft speed. Reservoir capacity is 0.4 gal. OD is 5". Length is 10¾", including shaft extension. Dry weight is 10 lb. Requires less than ½ hp at maximum pressure.

Designation: Hydro-Unit.—*Hein-Werner Corp., Waukesha, Wisc.*

Circle **308** on Reader Service Card

For more NEW PRODUCT reviews turn to page 128.



An easy "push" to connect and "pull" to disconnect is all it takes to operate the new Deutsch high-pressure fluid and gas coupling. No twisting or tricky lock movements are necessary. Here then is an effective design that can be specified for a variety of remote, umbilical, modular, or rack-and-panel applications. Safety at high operating pressures is assured by a color ring that provides visual inspection for positive lock.

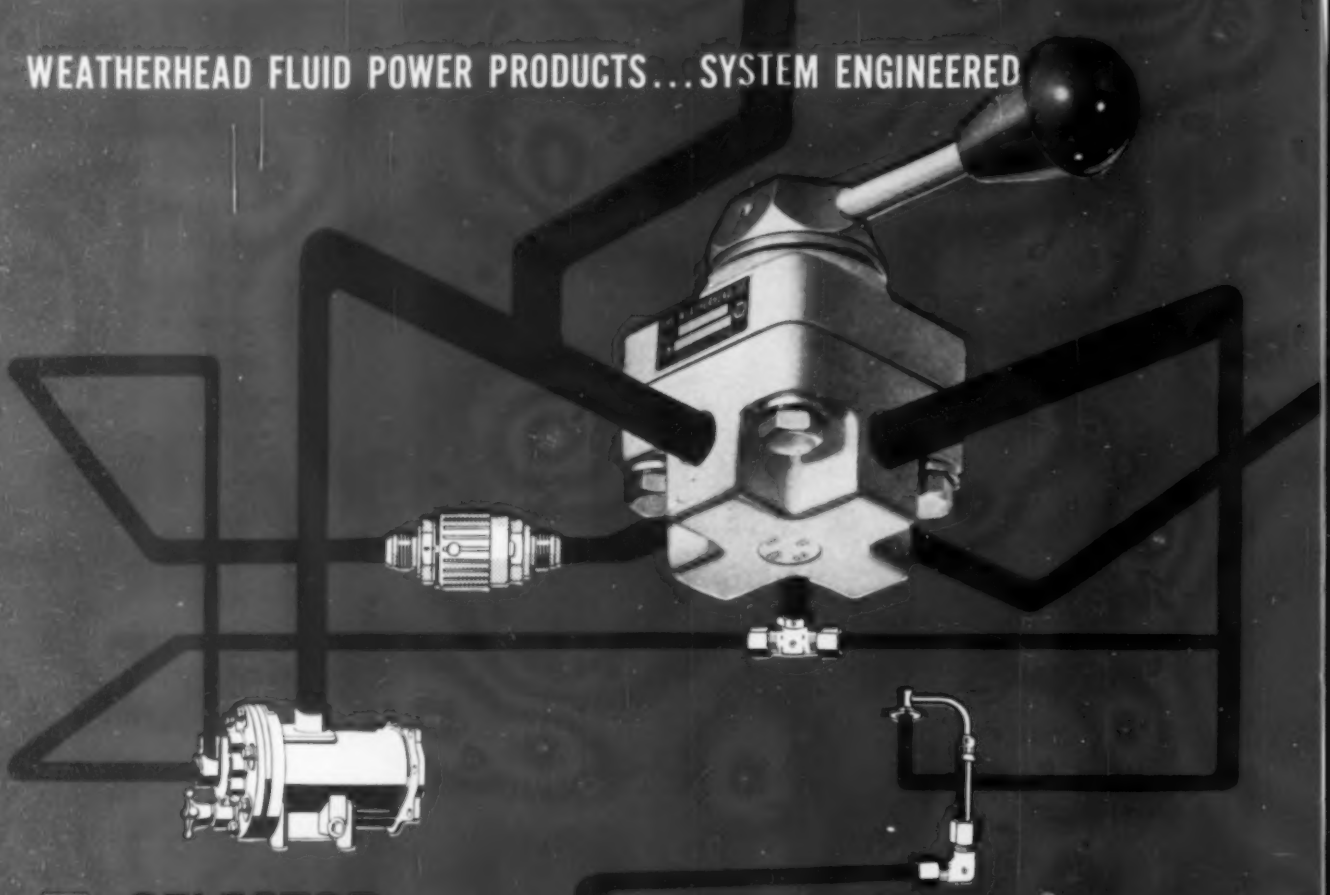
And both coupling halves exceed all requirements of MIL C-25427 for fluid loss, pressure loss, air inclusion, and physical shock. Temperature range is −200°F to +450°F.

To obtain complete technical information on this advanced specification fluid and gas coupling, write today for Data File H-10.

DEUTSCH

HYDRAULIC COMPONENTS DIVISION P. O. Box 73335 • 7000 Avalon Boulevard • Los Angeles 3, Calif.

WEATHERHEAD FLUID POWER PRODUCTS...SYSTEM ENGINEERED



SELECTOR CONTROL VALVES STANDARDIZED FOR ECONOMY... ENGINEERED FOR VERSATILITY

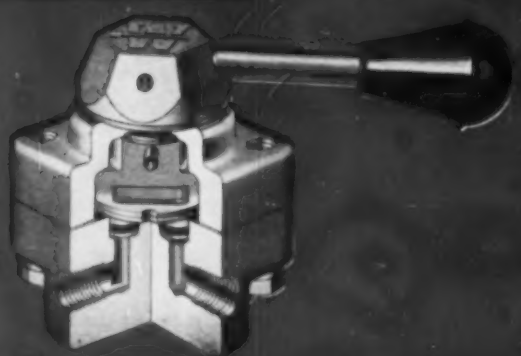
Unmatched economy is achieved by standardizing on a 4-way design, adaptable to 2 or 3-way selection. Greater versatility is provided because this advanced control monitors hydraulic or pneumatic flow pressures ranging from zero to 3000 psi.

These outstanding capabilities eliminate need for additional spare parts on intermediate pressure models . . . assure availability from distributor stock . . . simplify varied application needs over wide pressure range.

Weatherhead selector control valves offer: safe, smooth operation ■ positive sealing ■ spring centered, or detent position handles ■ horizontal or vertical ports ■ panel mounting or flexibility within the system.

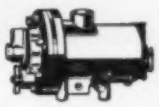
Contact your nearby Weatherhead distributor or write direct for latest brochure.

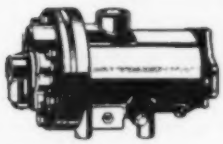
THE WEATHERHEAD COMPANY
CLEVELAND 8, OHIO



WEATHERHEAD
HYDRAULIC POWER
Components

VARIABLE DISPLACEMENT PUMPS

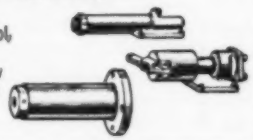




Meet J.I.C., S.A.E., and M.S. standards. Pressures to 3000 psi

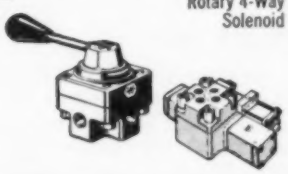
PUMP CONTROLS

Pressure Control, Automatic (Constant) Flow Control, Manual Displacement Control



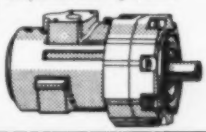
DIRECTIONAL CONTROLS

Rotary 4-Way Valves
Solenoid Valves



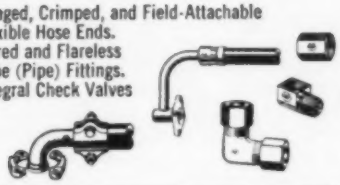
HYDRAULIC DRIVES

Fixed Displacement Hydraulic Motors, Reversible Variable Displacement Hydraulic Motors (Integrated Torque and Speed Control)



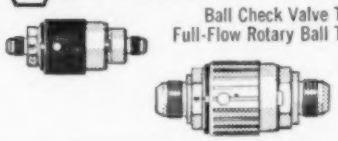
HIGH PRESSURE HOSE AND FITTINGS

Swaged, Crimped, and Field-Attachable Flexible Hose Ends. Flared and Flareless Tube (Pipe) Fittings. Integral Check Valves



SELF-SEALING COUPLINGS

Ball Check Valve Type
Full-Flow Rotary Ball Type



THE WEATHERHEAD CO.
300 EAST 131 ST. • CLEVELAND 8, OHIO
Distributors in all major markets

Circle **151** on Reader Service Card

NEW LITERATURE

Circle the numbers on the Reader Service post card for free copies

FILTER SYSTEM

Assembly has a self-priming pump, capacitor motor, iron filter chamber with glass fiber filter tube, and pressure gage, all mounted on a protable panel. Glass fiber filter tube gives depth filtration of particles down to 1 micron. Capacities from 30 to 1200 gph. Bulletin 809 contains details and prices. *Sethco Mfg. Co., Merrick, L.I., N. Y.*

Circle **400** on Reader Service Card

ROD WIPERS & O-RINGS

Two specification and data sheets cover polyurethane rod wiper/scrapers and O-rings. Wiper data includes physical characteristics of polyurethane. Wiper rings are one piece and snap into grooves. Resiliency helps wiper maintain positive contact on scored or pitted shafts. Made with ½-in. to 6-in. inside diameter, for pressures to 3000 psi. O-rings have low break–away friction and withstand 10,000 psi without back-up rings. *Disogrin Industries, Mount Vernon, N. Y.*

Circle **401** on Reader Service Card

HEAT EXCHANGERS

O-ring seals float the tube sheet and prevent damage from expanding and contracting. Made in one- and two-pass models with a variety of nozzle locations. Pressures to 150 psi. Tubes are made of admiralty metal and shell is steel. Shell diameters from 6¾ in. to 32 in. Bulletin 0-1162. *Basco, Inc., Buffalo.*

Circle **402** on Reader Service Card

POWER CYLINDER DATA

Bulletin shows this company's complete line of air and hydraulic cylinders and gives all information needed to select cylinders by size, thrust, bore, stroke, mounting, etc. Other useful information includes torque tables, charts on column strength, rod deflections, acceleration, factors of safety, pressure losses in pipes, cylinder forces, and other valuable data. (AJH-1048) *—Miller Fluid Power Div., Flick Reedy Corp., Bensenville, Ill.*

Circle **403** on Reader Service Card

LEATHER PACKINGS

Catalog details leather packings available in a variety of sizes and shapes including "U", cup, Vee, flange packings, gaskets, and washers. Book offers complete tannage and impregnation information (including new Moly S_2) as well as detailed design data including standard design dimensions, installation procedures, allowable clearances and ordering information. (AD-186)*—Garlock Inc., Palmyra, N. Y.*

Circle **404** on Reader Service Card

HAND PUMPS

Single acting hand pumps for pressures to 5000 psi and displacements of 0.9, 0.4, 0.17 cu. in. per stroke are described in an engineering bulletin. Pumps are made with or without reservoirs and built in relief valves. Bodies are high tensile cast iron and pistons are chrome plated steel. *The Sheffer Corp., Cincinnati.*

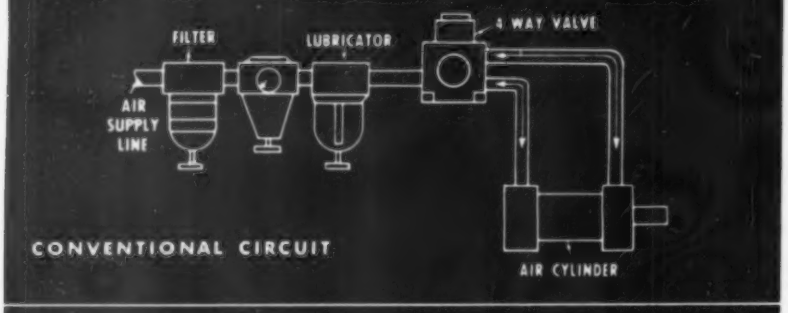
Circle **405** on Reader Service Card

PRESSURE GAUGES

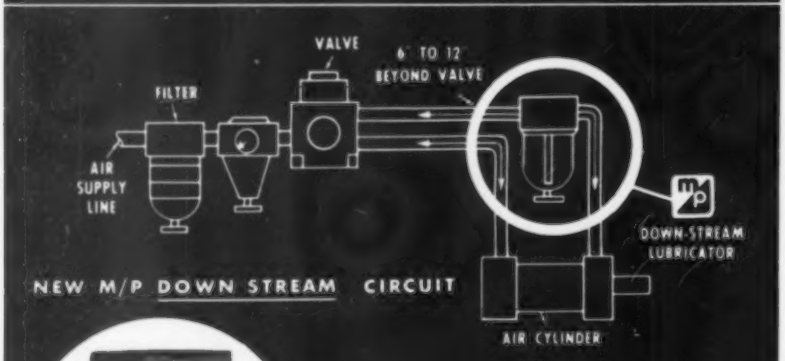
Dial sizes are 3 and 5 inch. Gauges are designed to maintain accuracy under extreme overload pressure, vibration, shock, and line pulsation. Use multi-wound helical coil for direct reading. Burst pressure is twice the maximum scale range. Accuracy is 1% of full scale range. Bulletin No. 280, gives pressure range, figure intervals, graduations, connections, and dimensions for each gauge. *American-Standard Controls Div., Detroit.*

Circle **406** on Reader Service Card

NEW m/p CONCEPT
OF AIR CYLINDER LUBRICATION



CONVENTIONAL CIRCUIT



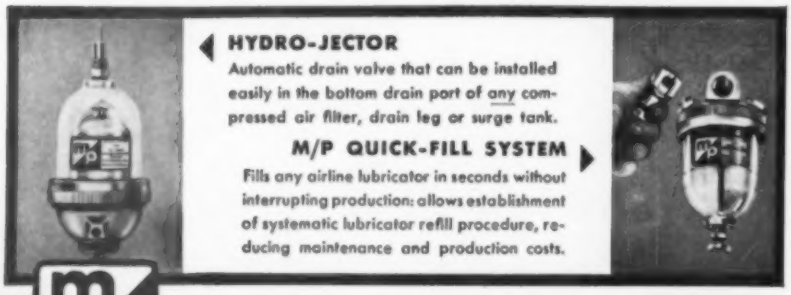
NEW M/P DOWN STREAM CIRCUIT

DESIGNED SPECIFICALLY FOR AIR CYLINDERS

With a conventional circuit the air cylinder may not be lubricated because oil introduced by the lubricator is trapped in the valve and exhausted to atmosphere. Any small amount of oil that works through the valve may also be exhausted when the cylinder is reversed.

Now . . . M/P has developed a new concept of air cylinder lubrication. The new Lubricator (Model M204) installed in the *Down-Stream Circuit* assures lubrication of both the control valve and the cylinder.

Contact your local representative or M/P for a detailed brochure.



HYDRO-JECTOR
Automatic drain valve that can be installed easily in the bottom drain port of any compressed air filter, drain leg or surge tank.

M/P QUICK-FILL SYSTEM
Fills any airline lubricator in seconds without interrupting production: allows establishment of systematic lubricator refill procedure, reducing maintenance and production costs.

MASTER PNEUMATIC, INC.
20430 SHERWOOD • DETROIT 34, MICHIGAN • Phone: TWinbrook 3-7070

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NEW LITERATURE

HYDRAULIC TUBING

Lectrosonic tubing assures ease of bending by using a controlled normalizing heat treatment process during manufacture. Accurate diameters and wall thicknesses make the tubing reliable for all types of connectors. Cold drawing gives smooth interior surfaces for minimum flow resistance. Data on quality control, manufacturing methods, and specifications are contained in Bulletin T435. *Babcock & Wilcox, Tubular Products Div., Beaver Falls, Pa.*

Circle **407** on Reader Service Card

AIR FILTER TEST

Test setup uses a lubricator to introduce a mist of oil into air entering the filter. The filtered air is released from a tube into a beam of light. Against a dark background, oil mist in the air leaving the tube is highly visible. Comparing the brightness of the air mist determines the performance of the filter. Bulletin 751 shows a setup using this test method and has photographs that compare various types of filters. *King Engineering Corp., Ann Arbor, Mich.*

Circle **408** on Reader Service Card

TUBE FITTINGS

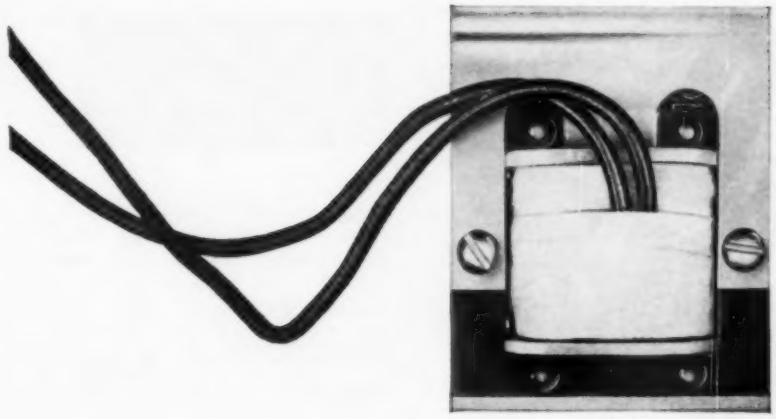
Specifications, dimensions, and cross-sectional drawings of a complete line of compression type tube fittings are covered in Catalog 4323. Included are fittings made of 316 stainless steel and brass. Fittings require low torque during assembly. This prevents distortion and gauling of the ferrule. The catalog also has an index to simplify fitting selection. *Parker Fittings & Hose Div., Parker-Hannifin Corp., Cleveland.*

Circle **409** on Reader Service Card

HELICAL GEAR PUMPS

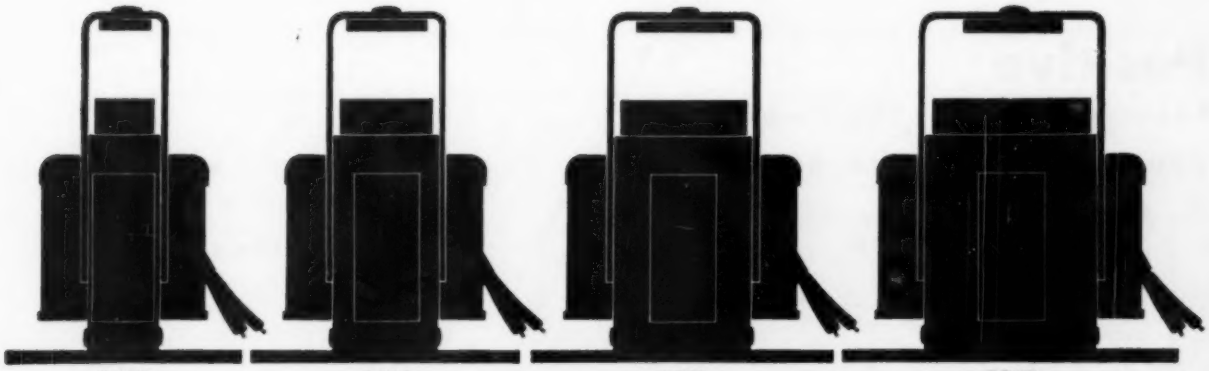
Capacities to 110 gpm, pressures to 400 psi. Hub, flange, or foot mounted, and direct, belt, chain, or gear driven. Lubricated by the liquid being pumped. Run quietly with only two moving

Continued on page 58



actual size

Single Purpose Solenoid ... National Acme's New "T" Type



T-APR T-BPR T-CPR T-DPR

(Silhouettes . . . 85% actual size. Push range up to eight pounds at ½" stroke.)

National Acme's new "T" Type solenoid is designed specifically and solely for hydraulic and pneumatic valve applications . . . proved by months of exhaustive testing by leading valve manufacturers. As you can see, there are four sizes offering a push range of two to eight pounds with up to a half inch stroke. The "T" Type is available with push pins of various lengths and diameters (captive or loose), and either a standard bobbin or epoxy molded coil. Get full details. Check with any of our nationwide staff of sales engineers, or, get in touch with us here in Cleveland. We'll look forward to hearing from you.

ELECTRICAL CONTROLS DIVISION

National Acme

THE NATIONAL ACME COMPANY
184 E. 131st STREET
CLEVELAND 8, OHIO

SALES ENGINEERS IN PRINCIPAL CITIES

AUTOMATIC PRESSURE CONTROL

Positive

insurance for the work!
protection for the system!

Use **FULFLO** Hydraulic Valves wherever specific pressure must be maintained: machine tool hydraulic systems, oil burning equipment, hydraulic rams and presses and other applications.

FULFLO design offers shear-closing action to eliminate chattering, sliding piston for full flow opening, easy adjustment within pressure range or quickchange of the pressure range . . . trouble-free service in any installation!

• Screw or flange models • Pressures to 500 pounds • Pipe sizes to 3" • Steel, cast iron or brass bodies • Brass, steel or stainless trim • All-steel for extra safety

SPECIALS engineered to your most exacting needs! For complete information, request a copy of the **FULFLO** Valves Mechanical Data Book with specifications, dimensions and engineering data.

THE FULFLO SPECIALTIES COMPANY, INC.
415 Fancy Avenue Blanchester, Ohio

Circle **48** on Reader Service Card

NEW LITERATURE

parts. Operate efficiently when rotated in either direction. Made with stuffing box or mechanical seal. With or without built-in relief valve. Pump speeds to 3600 rpm. Catalog S-F4176. *Roper Hydraulics Inc., Commerce, Ga.*

Circle **410** on Reader Service Card

MINIATURE 2-WAY VALVES

Designed for high capacity in a small envelope size, the shutoff valves are made with a wide choice of mechanical actuators. Poppet construction for high flow. All parts can be quickly replaced. Made in ⅛", ¼", and ⅜" NPT. Overall dimensions of the valves are 1" x 1⅛" x 1⅜". *Airmatic Valve, Inc., Cleveland.*

Circle **411** on Reader Service Card

AIR CONTROL PRODUCTS

The 48-page, digest-size catalog describes complete line of air and hydraulic equipment including cylinders, valves, rotating joints, filters, regulators, quick-acting couplers, and hose fittings. Dimensions, flow rates, operating pressures, and a number of typical air control circuits are illustrated. Color indexed for quick reference. Catalog 125. *A. Schrader's Son., Div. Scovill Mfg. Co., Inc., Brooklyn.*

Circle **412** on Reader Service Card

TEFLON SEALS

O-rings, backup rings, X-rings, and bellows, made of several different grades of Teflon are covered in bulletin R3017. Methods of quenching, compounding, stress-relieving, and molding are given. X-seal rings have a cross-section which eliminates the close tolerance generally needed with Teflon O-rings. Recommended for temperatures from −300F to 500F, for cylinders and valves. Sizes from 0.114-in. ID to 4.475-in. ID *Allegheny Plastics, Inc., Coraopolis, Pa.*

Circle **413** on Reader Service Card

For more reviews of FREE LITERATURE turn to page 146.

CALL

MELETRON

FOR ANY TYPE

OR SIZE

OF PRESSURE

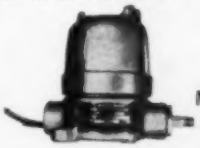
ACTUATED

SWITCHES

"When I need a pressure switch I know I can find exactly what I need from the Meletron line. I don't have to hunt for it or accept a substitute. And I can get it right away – from stock. ■ *I use Meletron* diaphragm switches *for vacuum and low-pressure applications, and the* bourdon tube switches *for high pressures (up to 15,000 psi). They respond to absolute, gauge, or differential pressures and may be* single setting, pressure difference *or* dual control *depending on the application. Reset may be either* automatic *or* manual.

Model 402

Model 420



Model 920

Model 372

Model 302

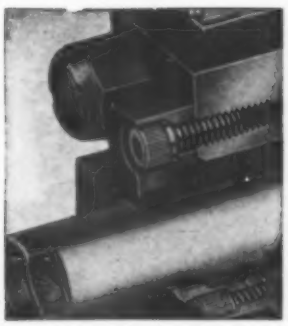
Model 1100

"Accuracy is within 2% of the adjustable range. ■ *Meletron Pressure Switches* operate at any altitude *and are* resistant to corrosion, vibration, shock, acceleration, extreme temperatures *and environmental conditions that affect other pressure sensing devices. I can also get them with a choice of housings – for* exposed mountings, explosion-proof, *or* stripped *for internal or protected mounting."* ■ *Meletron has been making pressure switches since 1940 for aircraft and industrial service and is the world's foremost manufacturer of pressure sensing devices. Write for catalog.*

MELETRON CORPORATION

950 North Highland Avenue • Los Angeles 38, California • HOllywood 3-4841

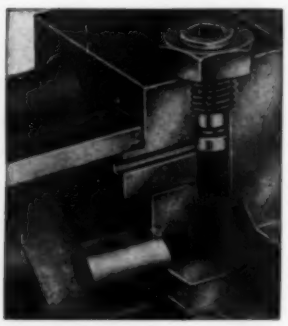
Do the cylinders you buy include these quality features?



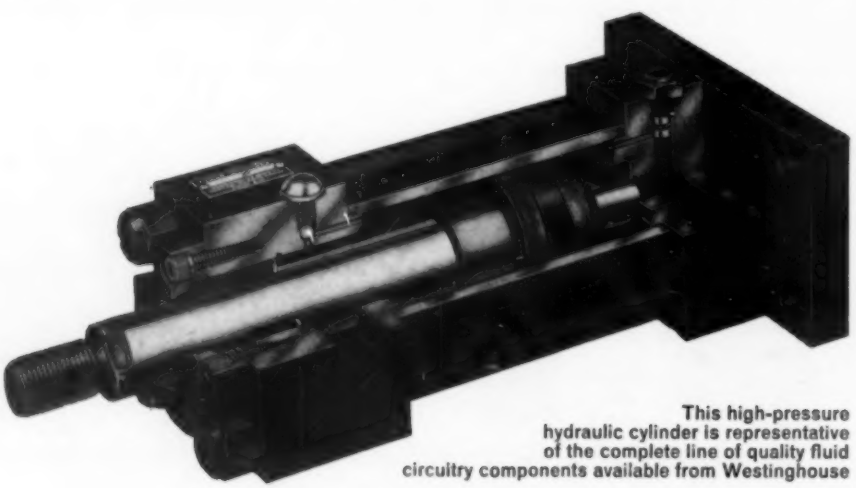
ROD GLAND—Easily removed. No need to loosen tie rods. Cuts maintenance time in half. Phenolic bearing insert will not score rod. Cuts replacement cost to a minimum.

ROD PACKING—Interlocking multiple lip seals require no adjustments; remain flexible under fluid pressure. Wear compensating function eliminates frequent replacement.

PISTON—Phenolic piston will not score tube. Packing cups used for proven long life and seal. Cups are easily replaced. Piston positively locked to rod.



CUSHION—Minimum clearance between piston and Meehanite Bushing combined with micrometer metering gives top cushioning efficiency and a wide adjusting range.



This high-pressure hydraulic cylinder is representative of the complete line of quality fluid circuitry components available from Westinghouse

if not, the chances are, your maintenance costs are higher than necessary. For more information about Quality Fluid Circuitry Controls for trouble-free automation, ask for Catalog A3-56.00.

See the Yellow Pages under Cylinders for the Name of Your Local Distributor, or refer to Sweet's Catalog, Product Design File.

WESTINGHOUSE AIR BRAKE COMPANY

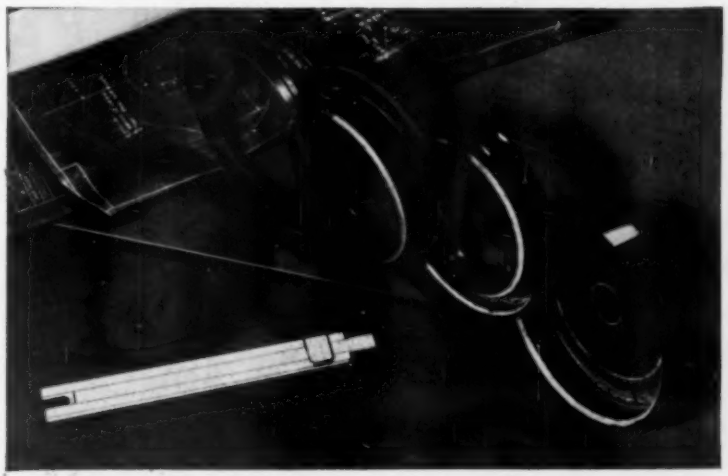
INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA

HOUGHTON CYLINDER AND ROD PACKINGS

What makes a good replacement packing?

In the maintenance of hydraulic and pneumatic equipment, the cost of the packings is relatively insignificant compared to production losses while the equipment is shut down plus the direct labor to install them.

For these reasons, maintenance men take every precaution to see that the replacement packings they install will provide the longest possible service life. Where operating temperatures do not exceed 200°F. (and most are below this temperature), this means *leather* . . . Houghton VIM leather packings. For temperatures from 200°F. to as high as 600°F. it generally means Houghton VIX-SYN fabricated rubber packings.



The important EXTRAS you get in Houghton VIM leather packings lie in quality of hide, special tanning, thorough impregnation and proven design.

What to look for in leather packings

Despite recent advances in rubber, synthetic and other packing materials, leather—probably the first packing material ever used—is still the most efficient and most economical packing for a wide variety of hydraulic and pneumatic applications.

In some few cases, maintenance men may fail to appreciate the great *economy* of first quality leather packings which assure efficient operation, exceptionally long service life and therefore, a very minimum of downtime.

VIM leather packings have long been recognized for their exceptionally long service life. This record is due to the rigid standards to which they are made. This involves careful selection of the hide, special mineral tannage, proper packing design and precision manufacture.

Impregnants are another important factor in evaluating leather packings. Until recently, wax was the only impregnant. Now, however, Houghton has perfected leather packings thoroughly impregnated with synthetic rubber. These packings (cups, U's, flanges or V's) assure you the excellent sealing qualities of rubber together with the low friction, long life and anti-extrusion qualities of leather.

Fabricated rubber for higher temperatures

Where temperatures consistently run above 200°F.—even as high as 600°F.—and where pH would affect the leather fibers, the best maintenance packing bet is fabricated rubber. VIX-SYN fabricated rubber packings are made in V and cup types using either duck or asbestos fabric and a wide range of rubber compounds.

Both laboratory testing and field experience have proven that Houghton VIX-SYN packings last longer. This longer service life is due to the quality of materials used and the method of manufacture. The lip bevel is molded—not cut. This procedure insures an unbroken coating of rubber at the bevel which seals against "wicking" action and they are coated with silicone oil for easy installation. Flake graphite is not used.

Another exclusive feature of VIX-SYN fabricated "V" packings is that they are made to standard J.I.C. stack heights. This means that they can be used to replace either homogeneous rubber or leather V's without need for spacers or other gland changes.

When efficiency and long service life are of prime importance—as they are to maintenance personnel—take advantage of the proven superiority of Houghton VIM leather or VIX-SYN fabricated rubber packings. Remember—it costs no more to install the best packings—packings that will multiply the time interval between necessary changes. Ask your Houghton Man or write for bulletins on VIM leather and VIX-SYN fabricated rubber packings. E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

Houghton

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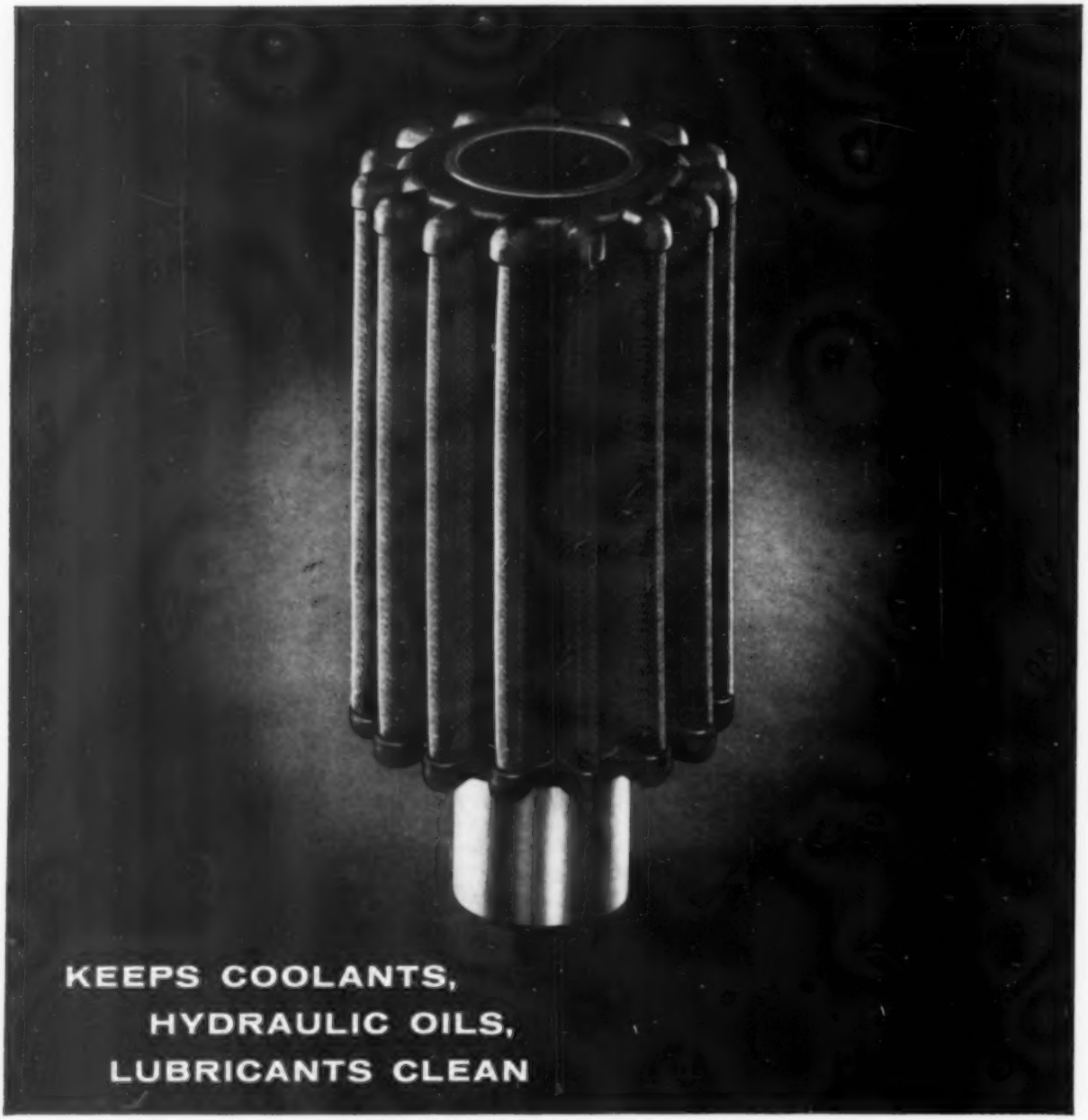

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By "trapping" dirt, sludge, rust, and abrasives, this Dollinger Staynew Sump Filter helps prevent pump failure, eliminates costly maintenance and replacement.

Available at a new, low price. Dollinger Staynew Sump Filters offer all the benefits of more expensive models . . . one-piece construction, exclusive radial fin design, molded end seals that resist all synthetics and mineral-base oils. Dollinger Sump Filters come in eight standard sizes with capacities from 50 to 100 GPM—larger capacities are attained by manifolding several units together. Mesh filtering medium is either 60 or 100 screen, depending on your efficiency requirements and fluid viscosity. For more information, write for Bulletin 330-H. Dollinger Corporation, O.E.M. Division, 65 Centre Park, Rochester 3, New York.

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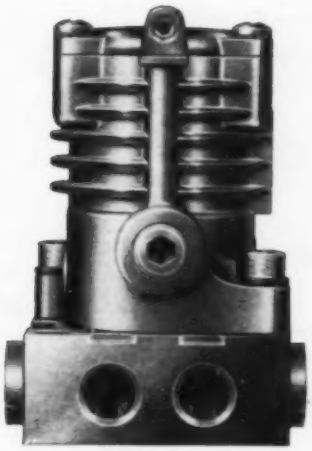

good things come in small packages!

Especially Valvair's Mini-King low-cost, miniature four-way valve . . . ideal for control of small double-acting cylinders and similar devices!

Valvair's Mini-King is remarkably compact . . . a mere 2⅞ inches wide—4 inches high . . . 37½ ounces light! And, it's lightning fast, too. Valvair ingenuity provides 4-way action with a standard Speed King pilot and a pressure-balanced shuttle in the lower body. Shuttle, stainless steel pilot plunger, piston and spring—are the only moving parts. Here's both performance and built-in multi-million cycle dependability!

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Bellows-Valvair

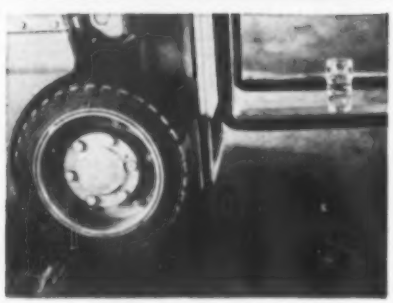
AKRON 9, OHIO

DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

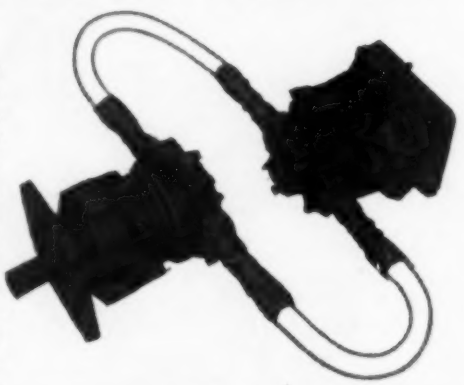
8123

Now Available in Production Quantities . . .
NEW HYDROSTATIC TRANSMISSION SYSTEM
THAT OUTPERFORMS ALL OTHER TYPES

With throttle set at idle, a DYNAPOWER-ed Lift Truck eases up, over and down obstacle without disturbing water in glass . . . will move as easily up and down grades; on ice and snow; over sand, gravel and mud.



DYNAPOWER®
PAYS OFF IN
PERFORMANCE



DYNAPOWER uses a separate axial piston hydraulic pump and motor that produces torque as required up to 300 lb. ft. The variable pump provides an infinitely variable speed ratio and displaces a maximum of 4.8 cu. in./rev. The transmission is rated at a normal 60 HP but handles peak requirements up to 90.

As a result, DYNAPOWER-ed off-road vehicles are able to deliver high torque at low RPM. Provide infinitely variable speeds in *either* direction without clutches or gear changers. Give faster smoother response. Reduce use of service brakes with Power Absorption Braking. And, simplify maintenance due to elimination of the drive train.

Application possibilities are endless. DYNAPOWER increases the power capabilities of LIFT TRUCKS without increasing size. DYNAPOWER increases useable HP output of FARM EQUIPMENT without prohibitive increase in cost. DYNAPOWER improves the vehicle geometry of MOBILE CONCRETE MIXERS and increases their capacity. DYNAPOWER reduces the high heat generation of constant volume open center type systems in SCRAPERS AND FRONTEND LOADERS.

DYNAPOWER has set new standards of performance and any off-road vehicle that cannot meet these standards will suffer in the buyers' market of 1962. Be sure you know all there is to know about DYNAPOWER, today! Write:

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FRANK L. MACKIN
Director

17th National Conference Industrial Hydraulics

DUNCAN B. GARDINER
Associate Director

WILLIAM R. SMITH
Secretary

VERSATILITY AND RELIABILITY OF FLUID POWER is the theme of the 1961 NCIH meeting. The two-day conference, on October 19 and 20 at the Sherman Hotel, Chicago, will meet in 12 technical sessions, a banquet, and two luncheons. The 28 papers will present advanced information on design techniques, components, and applications.

The conference is sponsored by the Graduate School of Illinois Institute of Technology and Armour Research Foundation of IIT. The Illinois and Chicago chapters of many national engineering societies are cooperating also. Purpose of these conferences, started in 1945, is to exchange information on the latest developments in the fluid power field.

Director of the 17th Conference is Frank L. Mackin. Associate Director is Duncan B. Gardiner, Director, Research & Development, Vickers, Inc., Div. Sperry Rand Corp. William R. Smith, Director of Cooperative Education, Illinois Tech, is Conference Secretary.

Program and abstracts of the conference papers are given on the following pages.

E. WIEDMANN
Pumps

Z. J. LANSKY
Pneumatics

C. C. MIESSE
Missiles & Space Hydraulics

K. G. HENRIKSON
Hydraulic Fluids

F. R. SWANSON
Machine Tools

M. G. SULSER
Materials Forming Machinery

F. H. WINTERS
Mobile Equipment

H. B. KOLM
Servo Mechanisms & Systems

PROG

NATIONAL CONFERENCE ON

THURSDAY, OCTOBER 19

8:00 A.M. Registration: Sherman Hotel, Chicago.

9:00 A.M. GENERAL SESSION

Opening: Frank L. Mackin, Conference Director

1) Presentation of awards to winners of HYDRAULICS & PNEUMATICS 1961 Prize Paper Contest, by Paul Rolnick, Vice President-Publishing Director, Industrial Publishing Corp., Cleveland.

9:30 A.M. MORNING TECHNICAL SESSION

Chairman: Duncan B. Gardiner, Vickers Inc., Conference Associate Director

1) "Management Control of Product Reliability," Leslie W. Ball, Director of Reliability, Aero Space Div., Boeing Airplane Co.

12:15 P.M. LUNCHEON

1) "The Individual and His Development in an Organization," Henry L. Porter, Executive Secretary, National Society of Sales Training Executives, Chicago.

2:00-4:30 P.M. AFTERNOON TECHNICAL SESSIONS (all held simultaneously)

Pumps

Chairmen: Ernst Wiedmann, George B. Miller

1) "Performance of Hydrostatic Transmissions," Warren E. Wilson, Chairman, Department of Engineering, Harvey Mudd College.
2) "Fluid Motor Drives for Precision Control of Rotary Motion," George Brand and Allen W. Salzman, Hartmann Manufacturing Co.

Pneumatics

Chairmen: Z. J. Lansky, James Fisher

1) "Blow Molding—Techniques and Applications," L. C. Morehouse, Jr., Packing Div., F. J. Stokes Corp.
2) "Hydro-Pneumatic Clamping in the Inchworm Motor," Phillip Ohringer, Airborne Instruments Laboratory, Div. Cutler-Hammer, Inc.

Automotive

Chairmen: Orvil F. Hoover, Forrest House

1) "Vehicle Ride Stabilization by Inertia Control," Dr. C. R. Hanna and W. O. Osbon, Westinghouse Electric Corp.
2) "Optimum Variable Hydraulic Servo Power Steering," H. E. Hruska, Chief Engineer, Power Steer-

R A M

INDUSTRIAL HYDRAULICS

ing and Drive Systems, Bendix Products Div., Bendix Corp.

Aircraft Systems

Chairmen: Robert Bayuk, W. G. Webster

1) "Design and Test of a High Temperature Hydraulic Control System," William E. Mayhew, Staff Engineer, Applied Research & Development, Republic Aviation Corp.
2) "Designing Reliability into Aircraft Systems," Robert P. Bielka, Transport Div., Boeing Airplane Co.
3) "A Realistic Approach to Hydraulic System Reliability," B. L. Mettee, Hydraulic Actuating Systems, Airborne Equipment Div., Bureau of Naval Weapons, U. S. Navy.

5:45 P.M. CONFERENCE SOCIAL HOUR

6:30 P.M. ALL-SOCIETY BANQUET

FRIDAY, OCTOBER 20

9:00-12:00 A.M. MORNING TECHNICAL SESSIONS (all held simultaneously)

Missiles and Space Hydraulics

Chairmen: C. Charles Miesse, Kurt Stehling

1) "Missile and Space Vector Control Hydraulics—Agena Space Vehicle," D. Youre, Senior Design Engineer; R. N. Franzle, Supervisor, Hydraulics and Pneumatics Group; W. R. Verbanec, Supervisor, Equipment Development Section, Guidance and Controls Dept., Lockheed Space Systems Div., Lockheed Missiles and Space Co.
2) "On Some Problems in Missile Hydraulic Thrust Vector Control Systems," R. F. Swettler, Subsystems Dept., Spacecraft Div., Aerojet-General Corp.
3) "Sealing in Severe Environments," Salvatore Cannizzaro, John Lee, Richard Schroeder, Fluid Systems Laboratory, Applied Research & Development Div., Republic Aviation Corp.

Fluids

Chairmen: Elmer Brennan, Karl Henrikson

1) "Air Bubbles in Oil—Their Effect on Viscosity and Compressibility," A. T. J. Hayward, National Engineering Laboratory, East Kilbride, Scotland.
2) "Dynamic Fluid Properties," Richard L. Leslie, Chief Chemist, Research & Development Dept., Vickers Inc., Div. Sperry Rand Corp.
3) "High Temperature Hydraulic Fluids," F. Damasco, and C. Spar, Fluid Systems Laboratory, Applied Research & Development, Republic Aviation Corp.

Components & Accessories

Chairmen: John T. Ellis, B. R. Teree

1) "A Power Unit for Industrial Hydraulic Equipment," R. L. Loup, Double A Products Co.
2) "Proportional Controlling With Alternating Current," Jule Hulman, President, United Controls Systems, Inc.

Machine Tools

Chairmen: Fred P. Swanson, R. C. Montanus

1) "Factors That Influence the Reliability of Hydraulic Machine Tools," Leo P. Gajda, Vice President of Engineering, Snyder Corp.
2) "Reliability Requirements of the Machine Tool User," L. J. Burza, Design Engineer, Preventive Maintenance, Plant Engineering, Ford Motor Co.

12:15 P.M. LUNCHEON

1) "Investment Practice and the Stock Market," James E. Day, President, Midwest Stock Exchange

2:00-4:30 P.M. AFTERNOON TECHNICAL SESSIONS (all held simultaneously)

Materials Forming Machinery

Chairmen: Melvin G. Sulser, Paul Rolnick

1) "Pressure and Position Control in Power Compacting," Fred W. Dorenbos, Clearing Div., U. S. Industries, Inc.
2) "Hydraulic Circuit and Component Design for Die Casting Machinery," E. Prince, Chief Engineer, B & T Machinery Co.
3) "Isostatic Pressing with High Pressure Hydraulics," Harry C. Jackson, Field Sales Manager, High Pressure Equipment Co.

Mobile

Chairmen: F. H. Winters, Verne P. Donner

1) "Hydraulic Power for a New Generation," E. H. Fletcher, Project Engineer, Engineering Research Div., John Deere Tractor Research & Engineering Center; and O. A. Smith, Project Engineer, Development Dept., John Deere Tractor Works.
2) "Hydrostatic Transmission Circuits," C. O. Weisenbach, Chief Engineer, Industrial Hydraulics Equipment, Watertown Div., The New York Air Brake Co.
3) "Development of Hydraulic Controls for Tandem Planetary Transmissions," Gordon W. Johnson, Supervising Engineer, Control Systems Laboratory Research Dept., Caterpillar Tractor Co.

Servo Mechanisms & Systems

Chairmen: Michael B. Scherba, H. B. Kolm

1) "Hydraulic Piston Motors in Servo Systems," Frank E. Hill, Staff Engineer, and Hugh B. Matthews, Staff Engineer, Aero Div., Vickers Inc.
2) "Electrohydraulics in the Printing Industry," Willard Walthall, Chief Application Engineer, Electric-Eye Equipment Co.

summaries of TECHNICAL PAPERS presented at the 17th NCIH

These abstracts were written by speakers at the NCIH for quick reference. Complete conference proceedings will be published in a bound volume early in 1962.

PUMPS

PERFORMANCE OF HYDROSTATIC TRANSMISSIONS

WARREN E. WILSON, *Chairman, Department of Engineering, Harvey Mudd College, Claremont, Calif.*

Predicting performance of hydrostatic transmissions over a wide range of speed, pressure, and fluid viscosity is difficult because of complex action within the system. This paper compares ideal performance with experimental data and shows methods of predicting performance. The need for better methods is emphasized.

FLUID MOTOR DRIVES FOR PRECISION CONTROL OF ROTARY MOTION

GEORGE BRAND *and* ALLEN W. SALZMAN, *Hartmann Manufacturing Co., Racine, Wis.*

Fluid motors have become important for rotary drives where precise speed control is required. A motor design which gives good control at all speeds, especially very low speeds, is discussed in this paper. The motor is hydraulically symmetrical, pressure balanced with liquid vanes on the rotor. Internal valving keeps supply oil on one side of the vanes, and discharge oil on the other side. Maximum pressure rating is 2000 psi; speeds range from 1500 to 3000 rpm depending on size. Minimum speeds range down to fractional rpm depending on the control system. Speed ratios of several thousand to one are possible.

The motor has linear output torque, low inertia, symmetrical reversibility, low compressed oil volume, and very good stall torque. These characteristics suit it for servo control systems, and the physical construction makes it adaptable for feedback circuits.

PNEUMATICS

BLOW-MOLDING—TECHNIQUES AND APPLICATIONS

L. C. MOREHEAD, JR., *Manager, Packing Div., F. J. Stokes Corp., Philadelphia, Pa.*

Blow molding techniques divide into injection molding and the production of a parison or preform. The parison method is accomplished by three types of equipment: dual manifold, common in the U.S., moving mold, pioneered in Europe; and rotary equipment for high volume.

The paper also discusses blowing techniques and the patents covering the various blowing methods. Clamping can be either hydraulic or pneumatic, and these are compared, as well as controls for other machine functions.

HYDRO-PNEUMATIC CLAMPING IN THE INCHWORM MOTOR

PHILLIP OHRINGER, *Airborne Instruments Laboratory Div., Cutler-Hammer, Inc., Deer Park, L. I., N. Y.*

The inchworm motor is a linear actuator which permits adjustments of several millionths of an inch. It works on the principle of magnetostriction—the property of certain alloys to change dimension in a magnetic field. The change is a function of field strength. With properly sequenced clamps, the actuator gives the minute increments which are required in through-feed, centerless grinding. The clamp must have high holding power and must prevent the armature from shifting during clamping and unclamping. Hydraulic clamps have met the requirements, and this paper gives details on clamp characteristics; manufacturing methods; and relationships of pressure, holding force, clamp clearance, and clamp thickness.

Wilson

Morehouse

Hruska

Hanna

Mayhew

AUTOMOTIVE

VEHICLE RIDE STABILIZATION BY INERTIA CONTROL

W. O. Osbon, *Section Manager, and* Dr. C. R. Hanna, *Electromechanics Dept., Westinghouse Electric Corp., Pittsburgh, Pa.*

The hydrauiic stabilization system described in this paper has been developed for superior riding qualities in automobiles. Acceleration sensing controllers are installed at each corner of the body. These control flow from a central hydraulic power source to four actuators which replace conventional shock absorbers.

The system greatly reduces the disturbing forces usually transmitted to the body. An outstanding feature of the stabilizer is its ability to bank the vehicle into a turn instead of allowing it to roll out as in a standard automobile. The system also eliminates pitching motions caused by rapid acceleration and braking.

After a brief discussion of vehicle suspension systems, the paper details the hydraulic controllers and actuators.

OPTIMUM VARIABLE HYDRAULIC SERVO POWER STEERING

H. E. Hruska, *Chief Engineer, Power Steering and Drive Systems, Bendix Products Div., Bendix Corp.*

Hydraulic power steering not only reduces manual force requirements but also permits reduced input travel. However input travel depends on speed. The ideal power steering system should have low sensitivity for high speed driving, but more desirable control characteristics throughout the remainder of the speed range. This paper describes a new power steering system which meets these requirements. The system was developed after study of driver motivation and response. The varying requirements of the steering system require versatility in the hydraulic power supply. Flow demand, high gain stability, and fluid temperatures were controlling factors in the final design.

AIRCRAFT

DESIGN AND TEST OF A HIGH TEMPERATURE HYDRAULIC CONTROL SYSTEM

William E. Mayhew, *Staff Engineer, Fluid Systems Laboratory, Applied Research & Development, Republic Aviation Corp.*

Development and testing of a 1000 F, 4000-psi system and its components is the subject of this paper. It outlines Republic's progress in the following areas:

- Fluids—These must have thermal stability, lubricity, corrosion resistance, and other characteristics at the high temperature. Fluid properties are compared and physical property tests conducted at Republic are explained.
- Seals—Test conditions and results of static and dynamic seals are presented with an evaluation of dynamic seal performance under temperature, pressure, and cycling. Metallic, wedge shaped seals, metallic composite seals, and proprietary seal designs are described.
- Pumps—Axial piston, variable displacement, pumps operating at speeds to 8000 rpm and temperatures to 700 F are described. Materials, plating processes, clearances are some of the development factors.

Other components which have undergone development in this program are filters, relief valves, check valves, flexible hose, and fittings. Performance test data on the complete system will be discussed with illustrations of environmental chambers, loading methods and other test techniques.

DESIGNING RELIABILITY INTO AIRCRAFT SYSTEMS

Robert P. Bielka, *Transport Division, Boeing Airplane Co.*

The design engineer's responsibility for reliability of a system of interrelated components, and the tools and techniques he can use are reported in this paper. Control measures for management to train individuals. The place of specifications and definition of reliability standards in the purchase order are reviewed. Also, a program of reliability analysis is presented.

A REALISTIC APPROACH TO HYDRAULIC SYSTEM RELIABILITY

B. L. Mettee, *Hydraulic Actuating Systems, Airborne Equipment Div., Bureau of Naval Weapons*

"Reliability" means different things to different people. To the statistician it is a mathematical definition. To the engineer it is confidence in his design. To the quality control man it is fewer rejections. To a mechanic it is fewer squawk sheets. To a pilot it is an aircraft that successfully performs its mission.

A continuing analysis of many failed hydraulic components and system malfunctions has clearly shown that reliability has been compromised in the original design concept for these reasons:

- Basically unsound design practices
- Unrealistic or insufficient testing
- Weight and cost saving
- Insufficient knowledge of maintenance capabilities.

This paper examines the problem areas and gives some of the techniques being considered by the Navy to increase reliability.

Bielka

Mettee

Franzle

Verbanec

Youre

MISSILES & SPACE HYDRAULICS

MISSILE AND SPACE VECTOR CONTROL HYDRAULICS—AGENA SPACE VEHICLE

D. Youre, *Senior Design Engineer*, R. N. Franzle, *Supervisor, Hydraulics and Pneumatics Group, and* W. R. Verbanec, *Supervisor, Equipment Development Section, Guidance and Controls Dept., Lockheed Space Systems Div., Lockheed Missiles and Space Co.*

The development of the hydraulic servo system for the Agena satellite vehicle's vector control. The system maintains vehicle attitude position during engine boost phases for orbiting. It has a prime power supply and linear servo actuators. Initially the power supply had batteries. Requirements for higher power-to-weight ratios, system simplification, and increased performance produced an integrated, engine fuel-driven system. The batteries, relays, and motor were eliminated, increasing system reliability and service life.

ON SOME PROBLEMS IN MISSILE HYDRAULIC THRUST VECTOR CONTROL SYSTEMS

R. F. Zwettler, *Subsystems Dept., Spacecraft Div. Aerojet-General Corp.*

A review and evaluation of various thrust vector control systems including jet vane, jetavator, gimballed engine, hinged and rotated engine, variable thrust engine, and fluid injection. Discusses typical problems in selecting a system for a particular vehicle and mission, and in developing a dynamic response characteristic required by the guidance system. A brief review of the design and development phases of an operational system using gimballed rocket engines is presented.

Of particular interest are some of the less predictable problems such as fluid contamination, gas dissolution in the hydraulic fluid, and O-ring groove dimensions.

SEALING IN SEVERE ENVIRONMENTS

Salvatore Cannizzaro, John Lee, *and* Richard Schroeder, *Fluid Systems Laboratory, Applied Research & Development Div., Republic Aviation Corp.*

Techniques to meet severe conditions of temperature, pressure, vibration, and fluid behavior. Viton O-rings and loaded Teflon back-ups for a 3000-psi, —65 F to 600 F hydraulic system using mineral oil are described. Also, non-elastomeric seals for this service, including designs fabricated from recently developed composite materials are presented. Butyl O-rings, Teflon back-ups and compatible seal lubricants for a 4000-psi, —65 F to +275 F pneumatic system are also discussed.

Gland configurations are considered with particular emphasis on optimum cavity, packing, and back-up dimensions. Surface finish, tolerance and clearance data are included. Anticipated performance and life, and effect on component design are evaluated in the paper.

Also discussed are boss seal designs of aluminum, steel, and titanium for positioning and non-positioning fittings at 4000 psi, —320 F to +800 F. Installation and assembly procedures, impulse and vibration test results, and reuseability data are presented with test procedures, equipment, and techniques.

FLUIDS

AIR BUBBLES IN OIL—THEIR EFFECT ON VISCOSITY AND COMPRESSIBILITY

A.T.J. Hayward, *National Engineering Laboratory, East Kilbride, Scotland*

An experimental study of the more important mechanical properties of bubbly oil is being carried out at NEL. A special viscometer has been built to measure bubbly oils. The effect of air bubbles on oil viscosity can be expressed as:

$$\mu_B = \mu_o(1+0.015B)$$

where μ_o = viscosity of bubble free oil

μ_B = viscosity of bubbly oil at the same temperature

B = bubble content, per cent

When bubbly oil is compressed, the bubbles of gas dissolve in the oil. The laws which govern the rate of solution are being studied. Solution takes place very rapidly when pressure is first applied, but the shell of oil around each bubble becomes rapidly saturated with dissolved gas, and then the rate of solution is very much reduced. Other conclusions are that bubbles dissolve much faster in low viscosity oil than in high viscosity oil; that a large increase in the applied pressure causes only a relatively small increase in the rate of solution; and that the inhibitors commonly added to hydraulic oil have only a relatively small effect on the rate of solution.

DYNAMIC FLUID PROPERTIES

Richard L. Leslie, *Chief Chemist, Research & Development Dept., Vickers Inc., Div. Sperry Rand Corp.*

Most hydraulic operations apply high forces to the fluids at high rates. The reaction of the fluid to these forces affects operation of the components. Adequate data on the fluids enable the analyst and designer to do a more efficient job. This paper discusses the effect of stress and rate of application of stress on hydraulic fluid reaction. The need of data in these areas is discussed, and some means of obtaining this information are suggested.

Zwettler

Cannizzaro

Lee

Schroeder

Hayward

HIGH TEMPERATURE HYDRAULIC FLUIDS

F. Damasco *and* C. Spar, *Fluid Systems Laboratory, Applied Research & Development, Republic Aviation Corp.*

Selection, properties, and dynamic fluid behavior of a hydraulic fluid for use at 700 F to 1000 F. Included in this review are mineral oils, silicones, esters, silanes, silphenylenes, organo-metallics, polyphenyl ethers, and liquid metals among others. Polyphenyl ethers, selected as the best balance of properties, are compared with the others. The chemical composition and reasons for the exceptional thermal stability of this class of compounds is presented. Methods and data on physical and chemical properties such as lubricity, bulk modulus, neutralization number, as a function of temperature and pressure are described and compared to more common fluids. Laboratory data is correlated with operational behavior in a simulated system. Dynamic fluid behavior is presented from completed tests.

COMPONENTS & ACCESSORIES

A POWER UNIT FOR INDUSTRIAL HYDRAULIC EQUIPMENT

R. L. Loup, *Double A Products Co.*

A review of basic reservoirs, methods of component installation, and operating characteristics of components, interrelationship between installation design and component design. Maintenance of the hydraulic unit as an additional design requirement. Discussion of an integrated system to meet all design features, considering fluids, components, accessories, operating demands, and maintenance.

MACHINE TOOLS

FACTORS THAT INFLUENCE THE RELIABILITY OF HYDRAULIC MACHINE TOOLS

Leo P. Gajda, *Vice President of Engineering, Snyder Corp.*

To a machine tool builder reliability means two things: 1. When the operator pushes the button, will the machine function? 2. How long will it continue to function and produce accurate parts? In hydraulic machine tools, the hydraulic components and their associated electrical controls are among the most important areas for reliability analysis. This paper presents the various components in terms of reliability and its effects on machine tool operation.

Special machine tools require close cooperaton between user and builder to evaluate component reliability. Means for user-builder information exchange are suggested.

MATERIALS FORMING MACHINERY

PRESSURE AND POSITION CONTROL IN POWDER COMPACTING

Fred W. Dorenbos, *Clearing Div., U.S. Industries, Inc.*

In compacting powers, the size and shape of the compact has a great effect on the compacting method. As the part size increases, the deformation of dies becomes greater, creating large clearances between the punches and dies. This causes flash and material faults. Also, as the part becomes larger, the ejection of the part after pressing becomes difficult.

For large rectangular shapes, box type dies are used in multiple ram presses having top, bottom, and side rams. As the size of these dies increases, and as the tonnage requirements increase, problems of flash and die scoring also increase.

Basic problems of die size and tonnage required in making rectangular bars are discussed. A unique hydraulic pressure and position control system is described.

HYDRAULIC CIRCUIT AND COMPONENT DESIGN FOR DIE CASTING MACHINERY

E. Prince, *Chief Engineer, B & T Machinery Co.*

The use of hydraulics on both hot and cold chamber die casting machines, including:

- Use of high pressure piston pumps at three pressure ranges, allowing accumulator charging and shot squeeze from a single hydraulic pump.
- Operating closing cylinder with large volume, low pressure combination for high speed.
- Use of large manifold blocks to limit hydraulic piping.

A new line of hydraulic valves is presented. These single body, dual control valves are designed to allow constant acceleration during the entire shot stroke with shot speeds over 1000 fpm. All controls for these valves are readily accessible and easily adjusted. Flow controls have graduated scales.

Leslie

Damasco

Spar

Gajda

Dorenbos

ISOSTATIC PRESSING WITH HIGH PRESSURE HYDRAULICS

HARRY C. JACKSON, *Field Sales Manager, High Pressure Equipment Co.*

The equipment and operation of isostatic pressing which has been important in economical production of large parts for space and nuclear fields. The process provides much closer control than other methods. High pressure hydraulics is important in this method and this papr discusses designs for simple operation and safety.

MOBILE EQUIPMENT

HYDRAULIC POWER FOR A NEW GENERATION

E. H. FLETCHER, *Project Engineer, Engineering Research Div., John Deere Tractor Research & Engineering Center*

O. A. SMITH, *Project engineer, Development Dept., John Deere Tractor Works*

New farm tractors being produced by John Deere have a central hydraulic system for power steering, power brakes, rockshaft operation, and operation of two remote cylinders. These tractors which are completely different from previous models gave an opportunity to study various hydraulic system designs. The system chosen is a closed center, constant pressure system having a variable displacement pump.

Design of the pump is detailed with performance comparisons with other pump types. Particular emphasis is on specific problems which were solved in the development of the system.

DEVELOPMENT OF HYDRAULIC CONTROLS FOR TANDEM PLANETARY TRANSMISSIONS

GORDON W. JOHNSON, *Supervising Engineer, Control Systems Laboratory Research Dept., Caterpillar Tractor Co.*

Early this year power shift transmissions were introduced in new models of Caterpillar wheel type tractors. Two planetary units in series are controlled with a common hydraulic system. One is a split-torque, three-speed automatic transmission which is attached directly to the engine and drives the other, a manually shifted range unit that mounts on the back of a bevel gear case and drives into it. Many new ideas were used to develop a hydraulic control system that gives smooth, fast shifts on the move with a minimum of effort or skill.

The cascading pressure relief system functions within a flow range of 6 to 57 gpm. Meeting the varied conditions induced by the pump, torque converter, and clutch pressure control circuits required solving problems of regulation, stability, and response. The large rotating clutches required dump valves to handle centrifugal pressures generated at speeds to 2000 rpm. Two methods were used to control rate of pressure build-up for smooth shifts: a flow control, accumulator combination; and pressure modulating reducing valves.

HYDROSTATIC TRANSMISSION CIRCUITS

CHARLES O. WEISENBACH, *Chief Engineer, Industrial Hydraulic Equipment, Watertown Div., The New York Air Brake Co.*

Discussion of a typical hydrostatic transmission circuit using a variable displacement pump and a fixed motor. These three applications are presented:

- Drum drive for a transit concrete mixer. Oscillograph traces show circuit behavior during a rapid change from full speed forward to full speed reverse under full load.
- Variation of the typical hydrostatic transmission using the overcenter pump in a closed circuit with a cylinder for vehicle steering.
- Constant speed drive for a locomotive air compressor. Oscillographs show starting and stopping cycle.

SERVO MECHANISMS & SYSTEMS

HYDRAULIC PISTON MOTORS IN SERVO SYSTEMS

FRANK E. HILL, *Staff Engineer*
HUGH B. MATTHEWS, *Staff Engineer, Aero Hydraulics Div., Vickers, Inc.*

In servo applications using present piston motors, advantages of high power-to-weight ratio, fast response, and high stiffness are balanced by the disadvantages of high breakout friction and high losses at low loads. The reasons for high breakout friction and losses are discussed, and methods for reducing them are shown. An integrated package incorporating a servovalve and an improved hydraulic motor is discussed from the viewpoint of both the designer and the servo application engineer. Static and dynamic data, both theoretical and experimental are presented together with transfer functions and design equations.

Prince

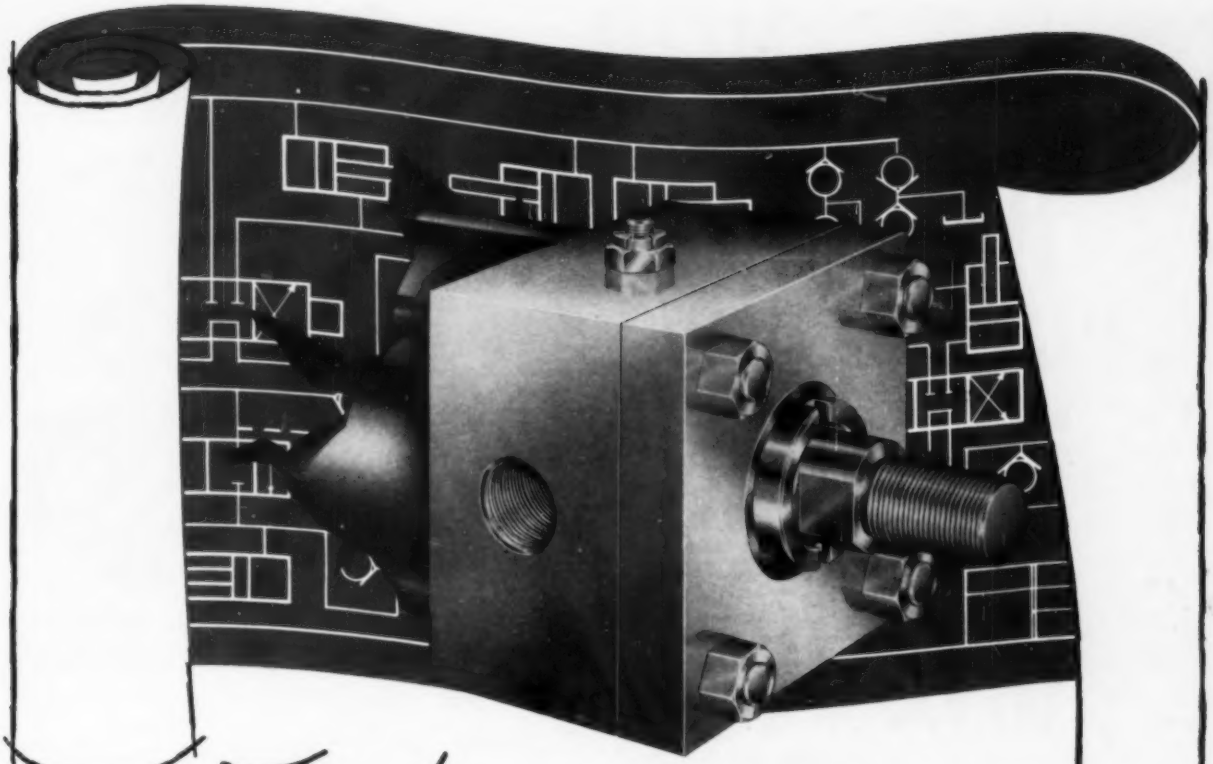
Jackson

O. Smith

Johnson

Hill

Matthews



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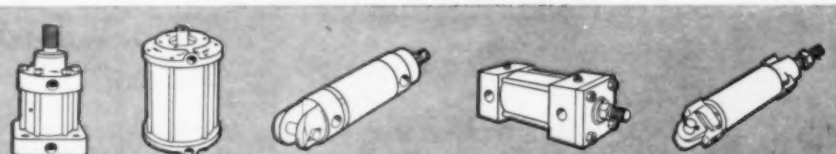

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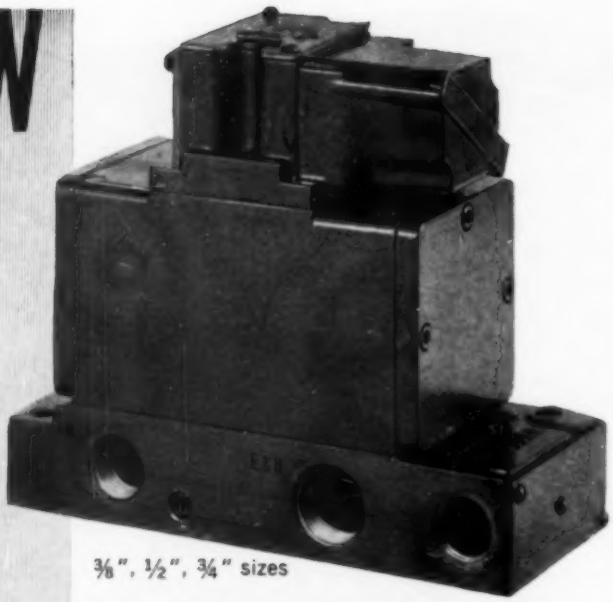

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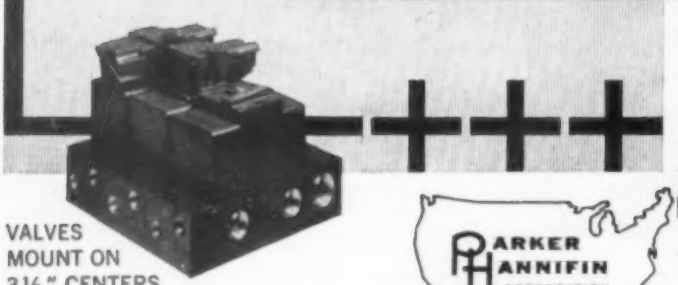

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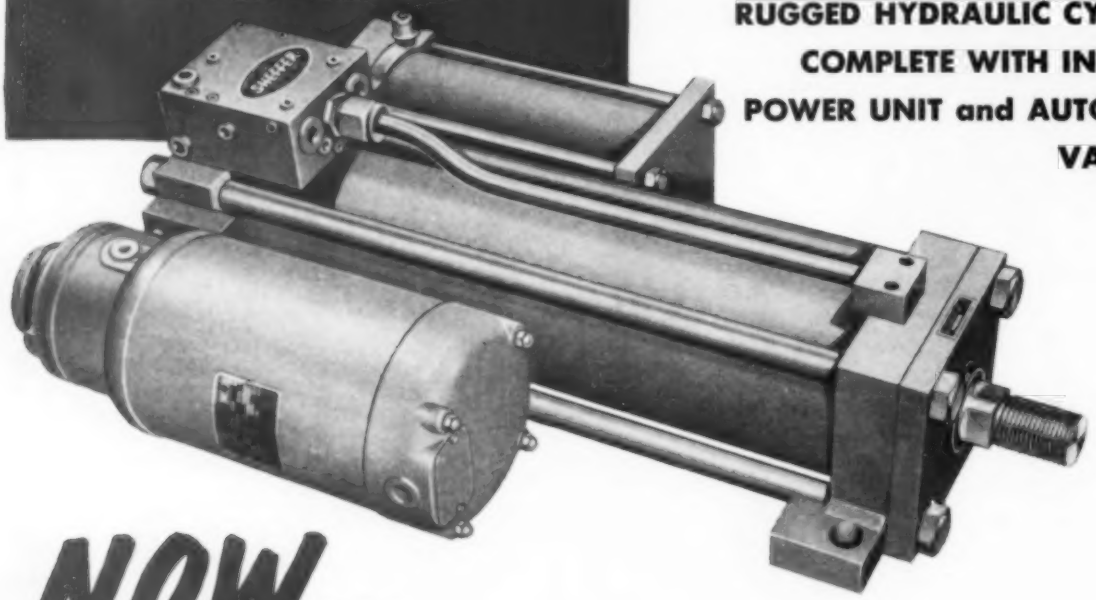

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Announcing

THE 1961 AWARD WINNERS

Each year the HYDRAULICS & PNEUMATICS Prize Paper Contest, which is open to all readers, produces papers describing many phases of hydraulic and pneumatic design, application, and maintenance. This year's entries represent advanced ideas in component design, machine system application, and theoretical development. These were judged by three outstanding authorities in the fluid power field: **Howard D. Davis,** Hydraulic Design Group Engineer, Convair Astronautics, **Frank L. Mackin, Walter M. Shaffer,** Staff Research Engineer, Towmotor Corp. Each entry was evaluated on the basis of practicality, economics, originality, and presentation.

On the following pages the award winners are presented together with the three top prize papers. All papers which have received an award or honorable mention will be published in future issues.

First
Award Prize
$500

Willis J. Taylor

INTERLOCKING AIR CIRCUITS FOR RELIABLE SEQUENCING

Working primarily with the petroleum industry has given Willis Taylor the background for his design for control of a gas line engine-compressor unit. In his present duties with Westinghouse Air Brake Co. he is concerned with pneumatic applications for oil well drilling, automatic production systems, pipeline automation, and engine control from 30 to 1500 hp. Before gaining his BSME degree from the University of Buffalo, he worked on design of hydraulic presses, preparing mechanical layouts and hydraulic circuits. He also has experience in materials handling and industrial automation equipment.

Second
Award Prize
$300

Grady Gilder, Jr.

George K. Fling

TECHNIQUES FOR DESIGNING AIRBORNE COMPONENTS

Originally an architect with a degree from Texas A & M College, Grady Gilder has gained aerospace experience at Chance Vought since he joined the company in 1953. His assignments have included design, analysis, and test of the Regulus and F8U hydraulic and punematic systems. He has been project engineer for the development, fabrication, and test of modular hydraulic systems, and now has responsibilities in system reliability and fluid dynamics research. He is active in Committee A6 of SAE and serves on the high temperature and metallic seals panels of that group. He is also on the hydraulic and pneumatic sub-committee of BuWeps-Industry Material Reliability Advisory Board.

During his five years with Chance Vought, George Fling has been assigned to research projects concerned with high temperature fluid systems. Previously, he worked on the design of the T-37 jet trainer at Cessna Aircraft Co. He received his BSME from Texas A & M College where he became a member of Tau Beta Pi honor society. He then attended Southern Methodist University where he received his MSME degree.

Third
Award Prize
$200

E. H. Fletcher

CLOSED CIRCUIT SYSTEM POWERS TRACTOR'S HYDRAULICS

Mr. Fletcher joined John Deere Tractor Works in Waterloo, Iowa after receiving his Bachelor's Degree in Mechanical Engineering from Kansas State University. After three years of Navy service, where he was engaged in optical research, he returned as project engineer in charge of hydraulic designs of Deere's newly formed Research & Engineering Center. He later transferred to the research department as staff engineer to the director of research.

Fourth—Seventh Prizes **$100 EACH**

E. Ledin & A. M. Harris, Staff Members, General Atomic Div., General Dynamics Corp., San Diego, Calif., "A Hydraulic Application on the HTGR Reactor."

Edward J. Lukes, Design Engineer, Elmes and King Mfg. Co., Cincinnati, Ohio. "Water for Hydraulic Control of Centrifugal Casting Machines."

R. N. Franzle, Supervisor, Hydraulic & Pneumatic Group, Space Systems Div., Lockheed Missiles and Space Co., Sunnyvale, Calif. "Oil-Line Dynamic Effect on Space Vehicle Hydraulic Servos."

Colin John Kirk, Technical Director, Martonair Ltd., Parkshot, England, "Modern Fluid Circuitry Signalling Developments Using Low Pressure Operators."

Honorable Mention

Arthur R. Allan, Principal Systems Engineer, Consolidated Systems Corp., Monrovia, Calif. "A Pitch-Heave Oscillator System for High Speed Hydrofoil Research."

Robert H. Bauer, Chief Engineer, Link Engineering Co., Detroit, Mich. "Impulse Hose Testing Machine."

Fred G. Brinkel, District Engineer, The Rucker Co., Los Angeles, Calif. "800 Ton Cold Exrusion Press."

Norman W. Carey, formerly Supervisor of Space Systems, Biomechanics and Nuclear Components, Armour Research Foundation, Chicago, Ill. "Increasing Valve Response."

Thomas Caywood, Development Engineer, Hydraulic Research & Mfg. Co., Burbank, Calif. "Performance Characteristics of a Pneumatic Servo Valve."

R. K. Cluphf, Engineering Section Head, for Airframe Design, and **R. H. Wood,** Engineering Writer, Sperry Utah Co., Salt Lake City. "Auxiliary Power Unit."

F. Cracknell, Design Engineer, The De Havilland Aircraft of Canada Ltd., Downsview, Ontario, Canada. "A Hydraulically Powered Aerodynamic Model."

Louis Dodge, Consultant, New Richmond, Ohio. "Has the Four-Way Valve Attained Perfection?"

Howard Q. Duguid, Head—Engineering Development, Shell Chemical Co., New York, N. Y. "Hydraulic Drive of Coal Feeders for Steam Generators."

Frank M. Elam, Hydraulic Design Engineer, and **James R. Vaughan,** Hydraulic Design Group Engineer, General Dynamics/Fort Worth, Fort Worth, Texas. "Protecting Hydraulic Instruments from High Frequency Pressure Impulses."

Kenneth L. Elkins, Sales Engineer, Mobile Power Brake & Equipment Co., Inc., Mobile, Alabama. "Simple Air Circuit Aids Ore Refiner."

Marshal E. Freeman, Project Engineer, and **James C. Gilmore,** Senior Associate Engineer, IBM General Products Div., San Jose, Calif. "Computer Memory Uses Digital Hydraulics."

L. L. Gherner, Work Manager, GECO Meccanica di Precisione, Caselette, Torino, Italy. "New Constructive Concepts in the Production of Constant Coupled Cylinder Pumps and Hydraulic Motors, of the Axial Plunger Type."

R. Wendell Goodwin, Systems Engineer, Norden Div., United Aircraft Corp., Norwalk, Conn. "Ideal Pressure Regulation and Relief with Direct-Acting Valves."

Russ Henke, Director of Research, and **John Beidenbach,** Project Engineer, Racine Hydraulics & Machinery, Inc., Racine, Wisc. "Computers: As Tools in Fluid Power Analysis."

Robert E. Hepinstall, Hepinstall Sea Elevator Co., New Orleans, La., "Hydraulic Computer Solves Offshore Transfer Problem."

Thomas Hodgson, B. C. Department of Highways, Allison Pass, B. C., Canada. "Hydraulics Simplify Winter Maintenance."

Nicholas S. Hodska, Design Engineer, Hydraulics Group, Sikorsky Aircraft Corp., Stratford, Conn. "Lever-Type Hydraulic Accumulator."

E. L. Holbrook, Barker Instrument & Machine Co., Inc., Charlotte, N. C. "Airtronics." and "An Air-Brained Scheme."

Norman T. Hull, Project Engineer, Hydraulic Research & Mfg. Co., Burbank, Calif. "Thrust Vector Control (T. V. C.) Systems."

Marek Jakubowski, Senior Research Engineer, R. C. Ingersoll Research Center, Borg-Warner Corp., Des Plaines, Ill. "Hydraulic System Analysis."

Arthur Liley, Sales Manager, Bellows-Valvair Ltd., Toronto, Ontario, Canada. "Fluid Power Solves Tough Straightening Problem."

Douglas M. Longyear, Chief Engineer, Hydraulics Engineering, Bendix-Pacific Div., Bendix Corp., North Hollywood, Calif. "Hot Hydraulics."

James C. McMartin, Vice President of Engineering, The Fenn Mfg. Co., Newington, Conn. "Booby Traps in Hydraulic Systems."

Alexander B. Magnus, Jr., formerly Design Specialist, Actuation Research Co., Burbank, Calif. "Evaluation of Oil Heating and Temperature Rise."

Alvin A. Meddock, Bendix Minuteman Program Manager, Bendix-Pacific Div., The Bendix Corp., North Hollywood, Calif. "Minuteman Trans-Erector."

Frank H. Miars, Mechanical Technician Supervisor, Lawrence Radiation Laboratory, University of California, Livermore, Calif. "High-Pressure Gas Intensifier."

George A. Morin, Philco Corp., Western Development Laboratories, Palo Alto, Calif. "Hydraulic Servo for Large Three-Axis Tracking Antenna."

B. R. Mueller, Manager, Tubular Specialties Sales, Pittsburgh Steel Co., Pittsburgh, Pa. "Basic Facts of Seamless Tubing for Hydraulic Cylinders."

B. Saelman, Engineer, Lockheed Aircraft Corp., Burbank, Calif. "Considerations in the Optimum Design of Hydraulic Systems."

Dr. M. P. L. Siebel, Chief Engineer—Pressure Equipment, Pall Corp., Glen Cove, N. Y. "Pressure Switches."

C. F. U. Stoner, Chief, Mechanical Design, Fairchild Aircraft and Missiles Div., Fairchild Stratos Corp., Hagerstown, Md. "A CSD for Engine Starting."

Michael Voytish, Jr., Staff Engineer, AiResearch Mfg. Div., The Garrett Corp., Los Angeles. "Evaluation and Utilization of Auxiliary Power Units."

Julian Wisnicki, Senior Engineer, Westinghouse Electric Corp., Pittsburgh, Pa. "Illustrating the Use of Air for Power and Control."

FIRST PRIZE

W. J. TAYLOR, *District Manager,*

Interlocking air circuits

The air control system to start a 1000-*hp engine-compressor performs operations in sequence with delays up to* 5 *minutes. Air is the only medium used for actuating and timing all circuit functions.*

HERE'S a completely automatic, air system that controls a 1000-hp engine-compressor in a gas pipeline station. Standard pneumatic components make up intricate sequencing circuits which start, stop and monitor the huge unit. The system continuously checks air, gas, and oil temperatures and pressures, and engine speed. If any of these drift from a safe range, an air horn blasts and the system determines whether the fault is serious enough to shut down the engine. The exact location of the trouble is indicated on a pneumatically actuated annunciator. Interlock valves and pneumatic timing reservoirs assure proper sequencing. The system is inexpensive, easily adapted to existing engine-compressors, and "explosion proof" by nature. Nearly all types of remote supervisory control can be coordinated with the engine system.

The 16-in. compressor gas suction, discharge, and by-pass valves are outside the station building. Each is controlled by a gas pressured, hydraulic actuator. The cooling water supply valves, starting air valves, and the fuel valve are operated by air cylinders. Except for the sensing devices and power operated gas, air, water, and fuel valves, all components are located in a control cabinet 84 in. high, 48 in. wide, and 32 in. deep. The master control and manual control valves are mounted on the door of the cabinet and connected to the control circuit by hoses.

• **Automatic Starting and Stopping**—The manually operated master control valve has three positions: OFF, RUN, and MANUAL.

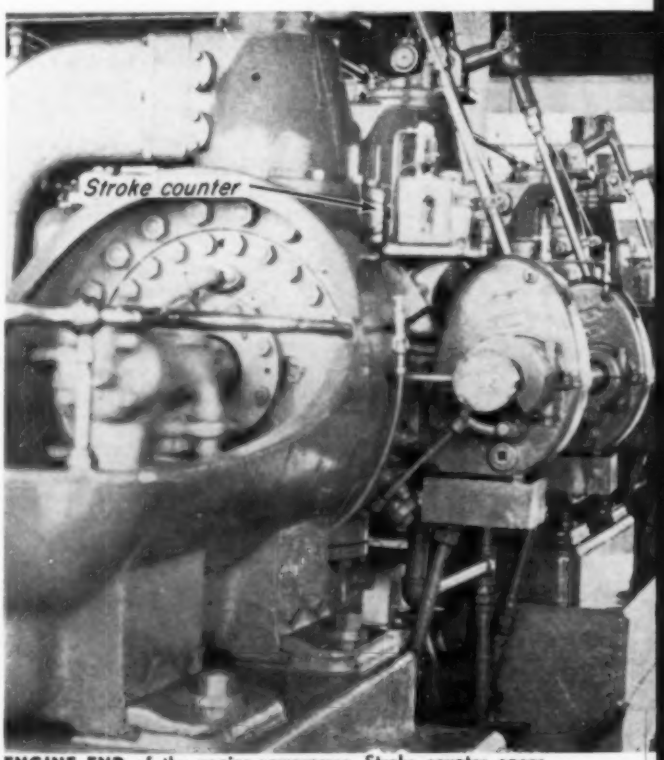
In the OFF position, the system is in readiness for a starting sequence, the gas suction and discharge valves are closed, and the by-pass open.

When the master control valve is moved to RUN, the system completes a starting sequence.

Moving the master control valve to OFF initiates and completes a stopping sequence.

In the MANUAL position, the automatic control portions of the system are cancelled and the only effective portions are the manual controls for the gas suction, by-pass and discharge valves.

The system senses critical pressures, temperatures, and speeds, and if one of these exceeds a safe value, the system sounds a warning and annunciates the dif-



ENGINE END of the engine-compressor. Stroke counter opens the starting air valve after the engine is slow rolled for 5 to 15 revolutions.

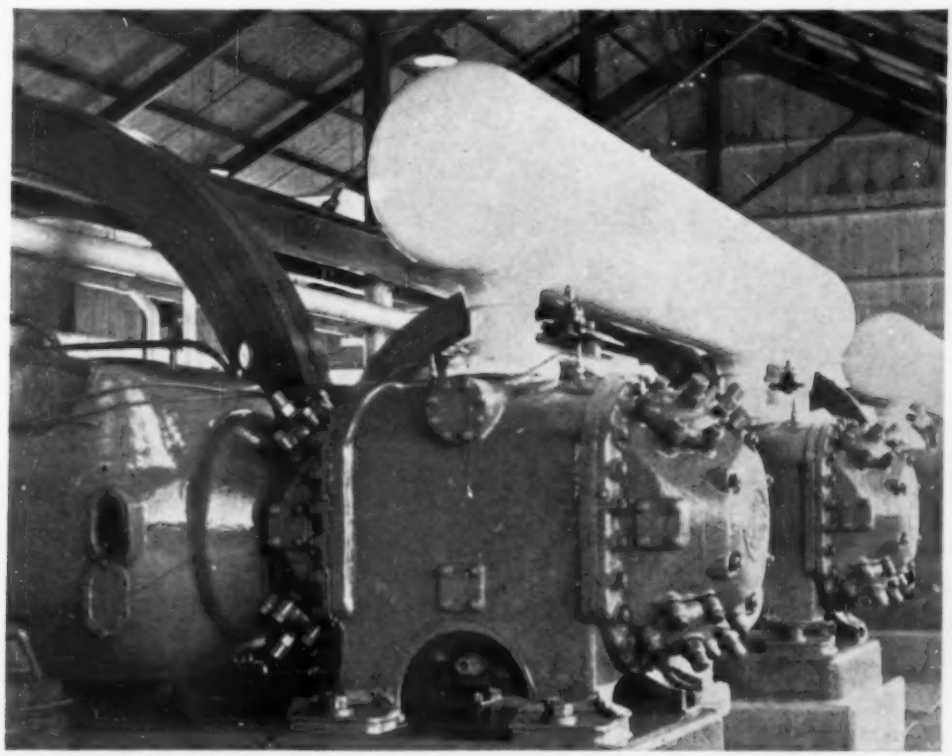
Industrial Products Div., Westinghouse Air Brake Co., Dallas, Texas

for reliable sequencing

ficulty. On some of these, shutdown sequence is also initiated automatically.

• **Starting Sequence**—When the master control valve moves to RUN, the system provides the following automatic starting sequence:

1. Checks the gas valves for proper starting positions.
2. Opens the gas discharge valve and the cooling water supply valves.
3. When the cooling water valves are fully opened, the system slow rolls the engine. A pneumatic stroke counter reads the number of revolutions the engine makes. This is adjustable from 5 to 15 revolutions. When the desired number of slow roll revolutions have been made, the larger main starting air valve opens.
4. At 35 rpm, the magneto system ungrounds and the fuel valve opens slowly. At the desired point during this step, the main starting air is shut off through an adjustable 0-60 sec. delay circuit.
5. When the engine has started and has reached 125 rpm, which is the full load speed, an adjustable warm-up period of 0-5 min. starts.
6. When the warm-up period ends, the system places the compressor on the line. To do this the gas by-pass valve slowly closes until the



SUCTION AND DISCHARGE LINES at the compressor end of the unit.

pressure differential across the gas suction valve drops to 30 psi. Movement of the by-pass valve is then stopped and the gas suction valve fully opened. The by-pass valve is then continued to the fully closed position.

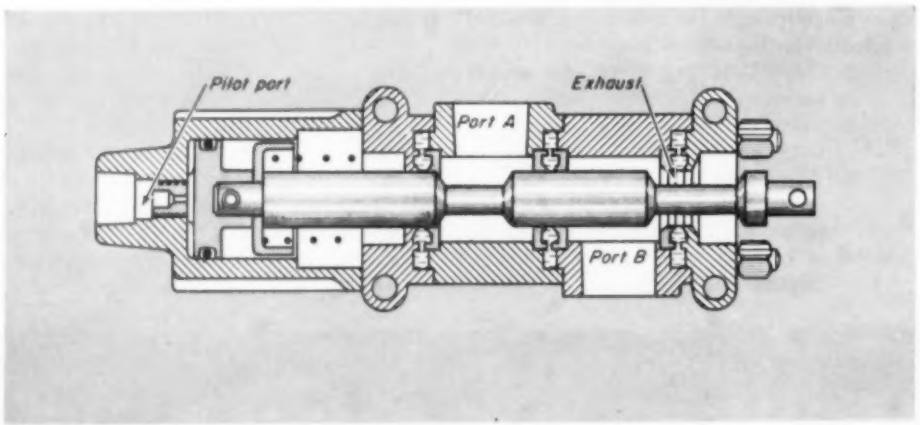
• **Stopping Sequence**—On command from the master control valve or a safety monitor trip, the system provides the following stopping sequence:

1. Immediately unloads the compressor by opening the gas by-pass valve, closing the suction valve, and closing the fuel valve.
2. After an adjustable 0-30 sec. delay, the magneto system grounds out.
3. Cooling period adjustable 0-5 min. begins.
4. At the end of the cooling period, the gas discharge and cooling water valves close.

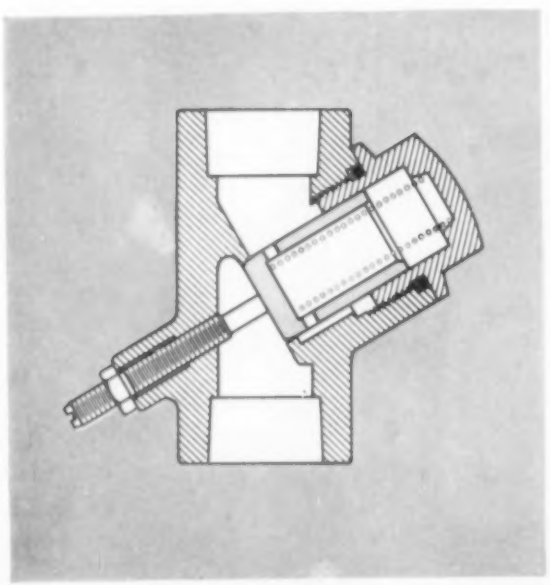
• **Safety Monitors**—Exceeding safe limits on the following pressures, temperatures, or speeds automatically begins a stopping sequence, starts an intermittent air horn warning, and shows a red flag at the appropiate annunciator window.

1. Low engine oil pressure
2. Low control air pressure
3. Low main air supply pressure
4. Starting sequence fault (Failure of the system to complete a starting sequence within a set time limit. Adjustable 0-5 min.)
5. High compressor gas discharge pressure
6. Low compressor gas suction pressure
7. Overspeed
8. High compressor gas discharge temperature

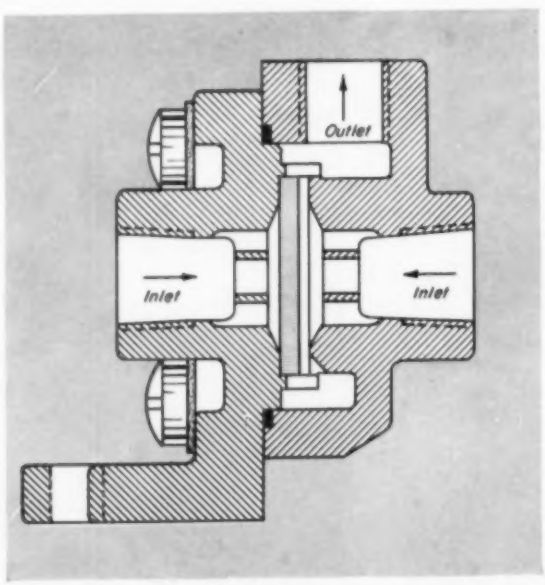
The following temperatures will sound the intermittent air horn warning and annunciate when their



PILOT-OPERATED, SPRING RETURN, 3-WAY VALVE used as an interlock valve in the circuit. In the valve's normal position, air is blocked at port *A* and port *B* exhausts. When pressure is applied to the pilot port the valve shifts, closing the exhaust and connecting ports *A* and *B*.



ADJUSTABLE FLOW CONTROL VALVE is used to regulate circuit timing by metering air in or out of timing reservoirs. To control flow, an adjusting screw positions a tapered poppet in an orifice. The poppet lifts for free reverse flow.



SHUTTLE VALVE selects air from one of two inlets and directs it to a common outlet. Pressure at either inlet port seals the rubber diaphragm against the opposite port and allows flow through the outlet.

normal values are exceeded but will not stop the engine.

1. High jacket cooling water temperature
2. High piston rod cooling water temperature
3. High main bearing temperature

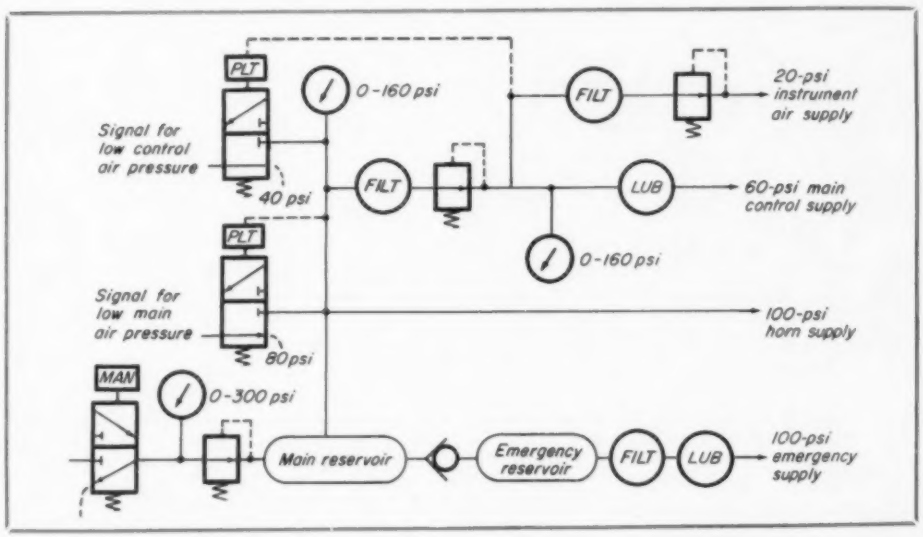
• **Interlocks Assure Proper Sequence**—If the main starting air is not applied at the specified time, the starting sequence will stop and indicate a starting sequence fault.

The low engine oil pressure safety interlock is not effective until the engine reaches a set speed.

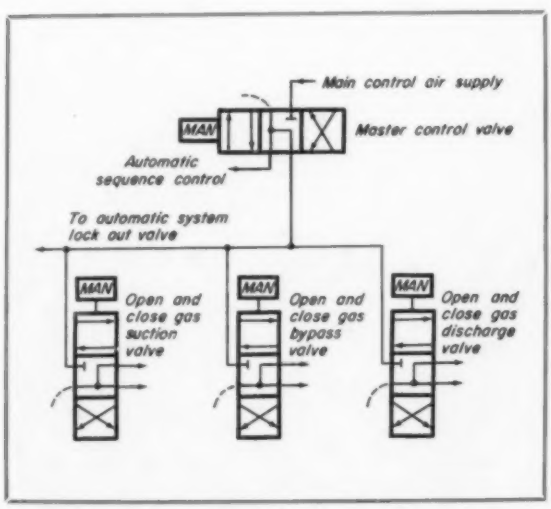
After a safety monitor shutdown, the master control valve must be shifted to OFF before initiating a starting sequence. This prevents the engine from restarting automatically.

The annunciator panel must show all green flags before a starting sequence can commence. Pushing the annunciator reset button will show an all green panel; but if one of the safety monitor values is not correct, the board will show red when the reset button is released and prevent a starting sequence.

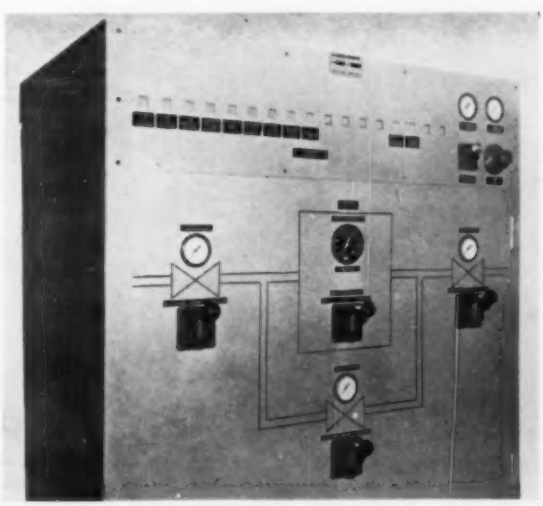
• **Standard Valves Sequence Circuit**—The above sequencing features are all done with pneumatic valves except for one air operated pressure switch used for ungrounding the magneto system at the time of ignition. The major sequences are controlled by ¼ in., 3- or 4-way, directional valves. With the exception of the pushbutton and handle operated manual valves, all these valves are operated by single or double pilot actuators with or without return springs. Adjustable flow control valves are used for the timing circuits. Quick release valves are used where a fast release of air pressure is needed, or where one portion of a circuit must be released before a subsequent section. Modulated instrument pressure of 3 to 15 psi is sensed by diaphragm-operated, three-way valve with an ad-



AIR SUPPLY CIRCUIT furnishes air at three different pressures to the circuit. Pilot valves signal the safety monitor valves for a shutdown if control pressure drops to 40 psi, or main air pressure falls to 80 psi.



MASTER CONTROL VALVE manually selects either the automatic sequencing circuit or manual controls for the gas valves. The gas suction, bypass, and discharge valves can be controlled independently.



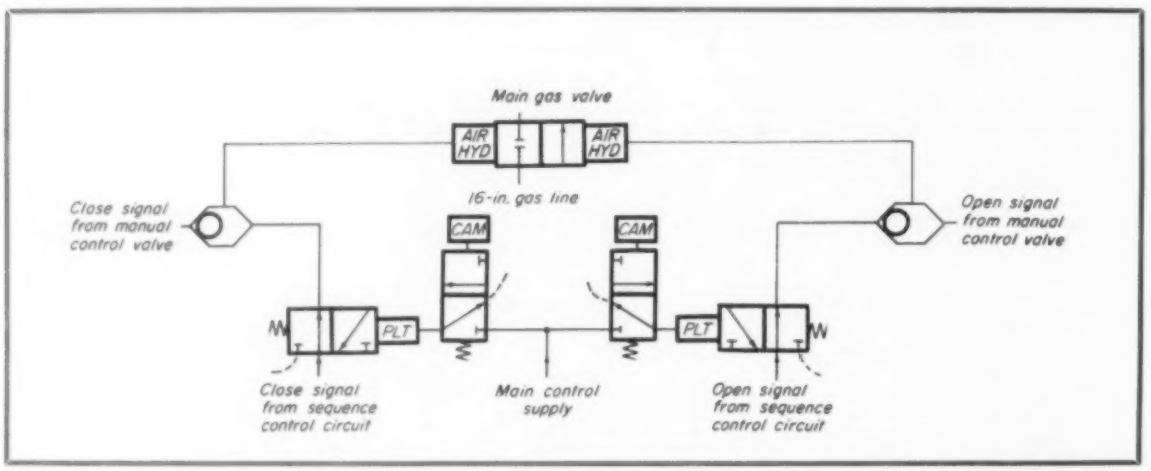
MANUAL CONTROL VALVES mount on the front of the master control cabinet. The annunciator windows are at the top.

justable spring. When a sequence step is initiated from several different signal lines, shuttle valves are used.

• **Main Air Supply System**—Air at 100 psi is fed to the main reservoir through a pressure regulating valve. An emergency reservoir connects to the main reservoir through a check valve. If the main air supply fails, the check valve holds 100 psi in the emergency reservoir. This is sufficient to operate all the gas valves to the OFF position. Additional pressure regulators maintain 60 psi for the main control supply and 20 psi for the instrument supply.

• **Manual Control**—The gas suction, by-pass, and discharge valves may be opened and closed manually or automatically. A 4-way master valve in the 60 psi control circuit directs air to either the manual or automatic sequencing circuits. In its center, or OFF, position, both circuits exhaust. This valve keeps the automatic sequencing circuit and the manual circuit separated.

• **Main Gas Valve Control**—Each of the 16-in. gas plug valves is operated by a gas pressured, hydraulic actuator with self contained valving. The plug of the valve is moved by a double-acting, rotary vane, hydraulic actuator with 90 degree movement. This actuator is fed by oil tanks which are pressured from an air-piloted, spring-centered, 4-way valve. The oil tanks use pipeline pressure of over 500 psi to develope the



MAIN GAS VALVE ACTUATORS receive "open" and "close" signals through a shuttle valve. Signal may originate at the manual control valves or the main sequencing circuit. Cam valves, actuated by the gas valve's control lever, remove the signal when the valve opens or closes fully.

GAS-PRESSURED, HYDRAULIC ACTUATOR for opening and closing the suction valve mounts directly on the valve and is self-contained. A differential pressure transmitter measures the pressure drop across the valve and transmits a 3 to 15 psi instrument signal to the sequencing circuit. The low suction pressure valve signals the engine-compressor if the suction pressure falls too low.

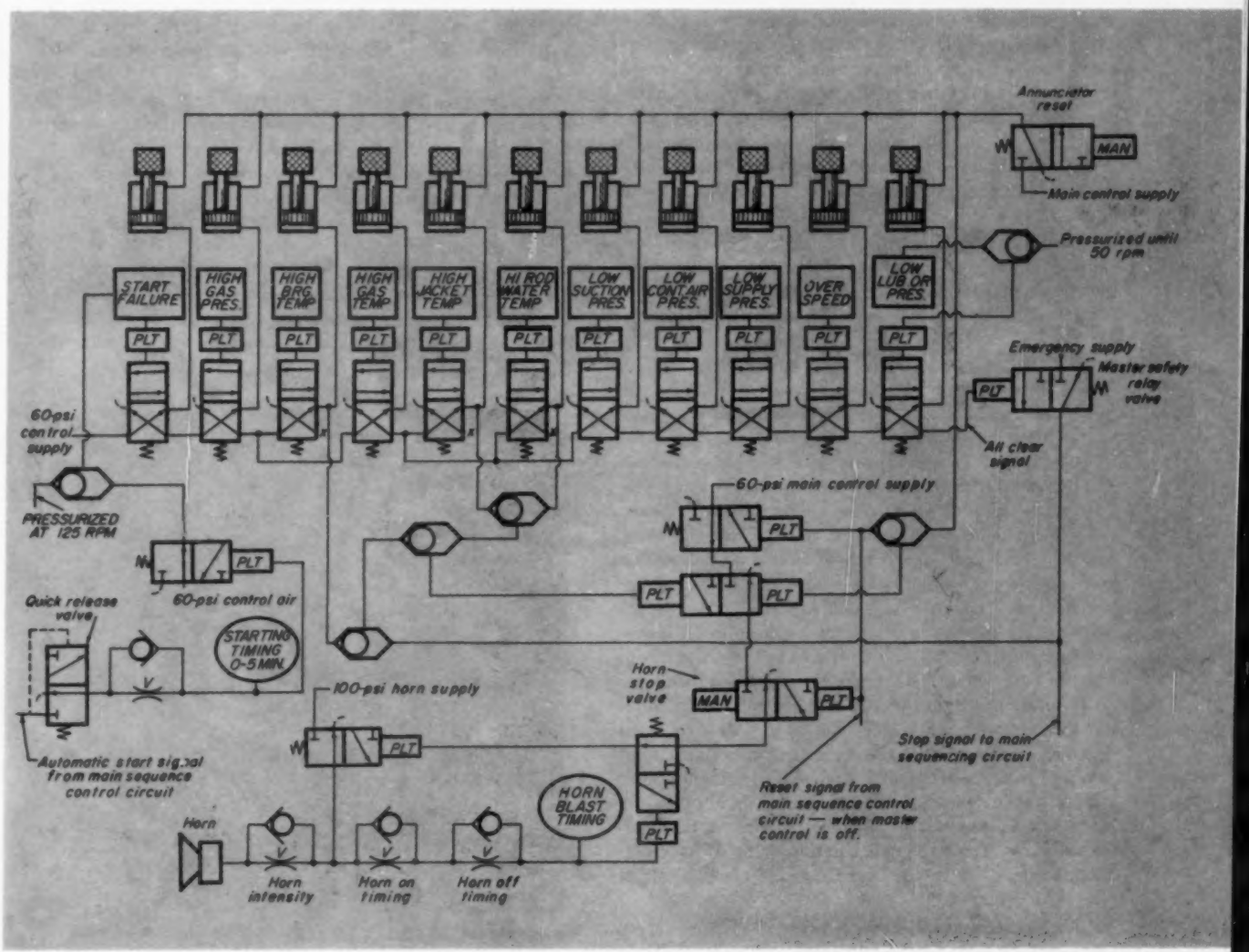
ANNUNCIATOR CYLINDERS AND CONTROL VALVES are mounted at the top of the master control cabinet.

hydraulic pressure for the rotary actuator. The 4 way actuator control valve is shifted by pressurizing the OPEN or CLOSE signal lines. When the main gas valves are fully opened or fully closed, they actuate cam operated, 3-way, valves to provide OPEN and CLOSED signals to the main sequencing circuit. A cam operated, pressure modulating valve is moved proportionately by the main valve actuator during its stroke. This pressure provides a relative position indication on a calibrated pressure gauge. Pilot-operated, 3-way valves exhaust the actuating lines when the gas valve is fully open or fully closed. Shuttle valves allow operation of the valve from the automatic or manual circuits.

• **Safety Monitor, Annunciator, And Horn Circuits**—Values of temperature, pressure, and speed are sensed by normally open, 3 way valves attached to pressure or temperature sensing devices. Supply pressure passes through these valves to the pilots of 4-way relay valves. The relay valves are in series and allow control air flow to the pilot of the master relay valve, only if all monitored values are normal. This circuit fails safe because a loss of air at the master relay valve indicates an abnormal value and starts a safety shutdown.

The valves in this series which indicate high jacket cooling water temperature, high piston rod cooling water temperature, and high main bearing temperatures are by-passed. High temperatures in these circuits indicate on the annunciator and sound the warning horn, but do not shut down the engine.

When pressure is released from the pilot of any of these monitoring valves, the valves shift and direct pressure to the head end of a small double acting cyl-



SAFETY MONITORING, WARNING, AND SHUTDOWN CIRCUIT continuously checks pressures, temperatures, and speeds. The 4-way pilot-operated valves are held actuated by an air signal passing through normally-open, pressure, temperature, and speed sensing valves. An unsafe condition blocks the signal and lets the 4-way valve spring-shift, sounding the warning horn, and annunciating the trouble.

The START FAILURE annunciator valve is held shifted by air pressure from a normally-open relay valve. If the engine is not up to 125 rpm when the reservoir times out, the annunciator valve is released and the engine shuts down. A pilot-interrupt circuit provides an intermittent horn blast.

INTERLOCKING AIR CIRCUITS

inder which raises a red flag in the panel window. These annunciator cylinders are retracted by depressing the reset valve, applying air pressure to the cylinder rod ends.

One of the valves in this series signals any fault in the starting sequence. A timing reservoir in this circuit delays pilot pressure buildup on a normally open 3-way valve which holds the relay depressed. As this reservoir times out, it will release the relay causing a fault, but if the engine is up to full speed (125 rpm) before the reservoir times out, the STARTING FAULT monitor valve is held open by a signal through a shuttle valve.

An air horn gives a warning signal when any of the circuit monitor valves shift. The horn signal is cancelled by a manual valve, or by placing the master control valve on OFF. The warning horn cycling valves are in a pilot interrupt circuit to give an intermittent horn blast. The horn ON and OFF periods are both variable. They are adjusted by variable flow control valves in the pilot circuit of the interrupt valve. A separate adjustable flow control valve varies the intensity of the horn.

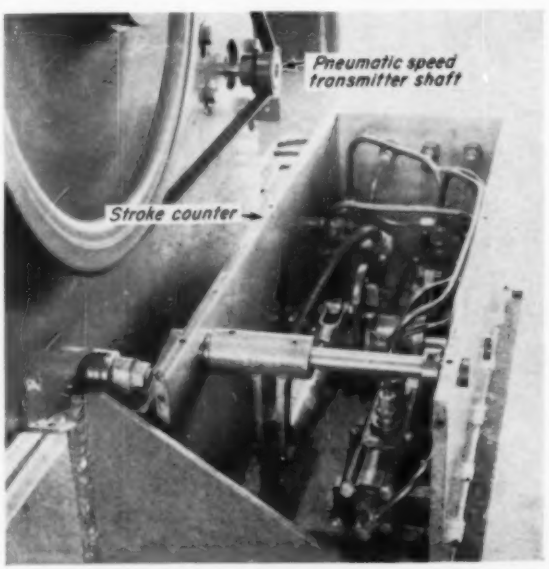
• **Starting Air Circuit**—The engine is rolled for starting by applying 250 psi starting air directly to the engine pistons through a distribution system which is part of the engine valving. The main 2 in. starting air valve is paralleled by a ½-in., 2-way valve. This small valve permits a choked supply of starting air for slow rolling the engine. Slow rolling is required to purge the engine cylinders of any condensation which might have accumulated during shutdown.

This circuit contains a slow roll stroke counting mechanism. On signal from the main sequencing circuit for slow roll, this device raises a cam follower into interference with a round nosed cam, revolving with the engine in a 1:1 ratio. Each time the engine makes one revolution, this cam strokes a ratchet mechanism. Over an adjustable period of 5 to 15 strokes, an internal cam advances to pilot-shift the starting air control valve, opening the large 2-in. starting air valve. The next few strokes of the engine continue to advance the ratchet mechanism until another internal cam valve releases a spring returned cylinder. This removes the operating cam from interference with the engine driven shaft, reducing wear on the stroke counting mechanism, as it is in operation only during the starting sequence. After a predetermined delay, the starting air timing valve shifts, closes both starting air valves, and resets the mechanism for the next cycle.

• **Engine Speed Sensing Circuit**—Engine speed is sensed by a magnetic-pneumatic transmitter driven through a 10:1 ratio from the engine shaft. The pneumatic transmitter has a linear output of 3 to 15 psi over a 0 to 1600 rpm variation of its input shaft. The 10:1 ratio drive results in a 3 to 15 psi modulated signal through 0 to 160 rpm of the engine. This output is fed to a calibrated pressure gauge on the panel for continuous rpm indication. The output is also fed to four, adjustable, diaphragm operated, 3-way valves for sensing various speeds. At 30 rpm, a valve operates to release the low oil pressure safety circuit which is held ineffective during initial starting. At 35 rpm, a signal is provided to the main sequencing circuit to open the fuel valve and unground the magneto system. At full load speed of 125 rpm, a signal is provided to the main sequencing circuit to start the warm-up timing period, and to cancel the starting sequence fault time-out. The overspeed safety circuit is sensed at 140 rpm.

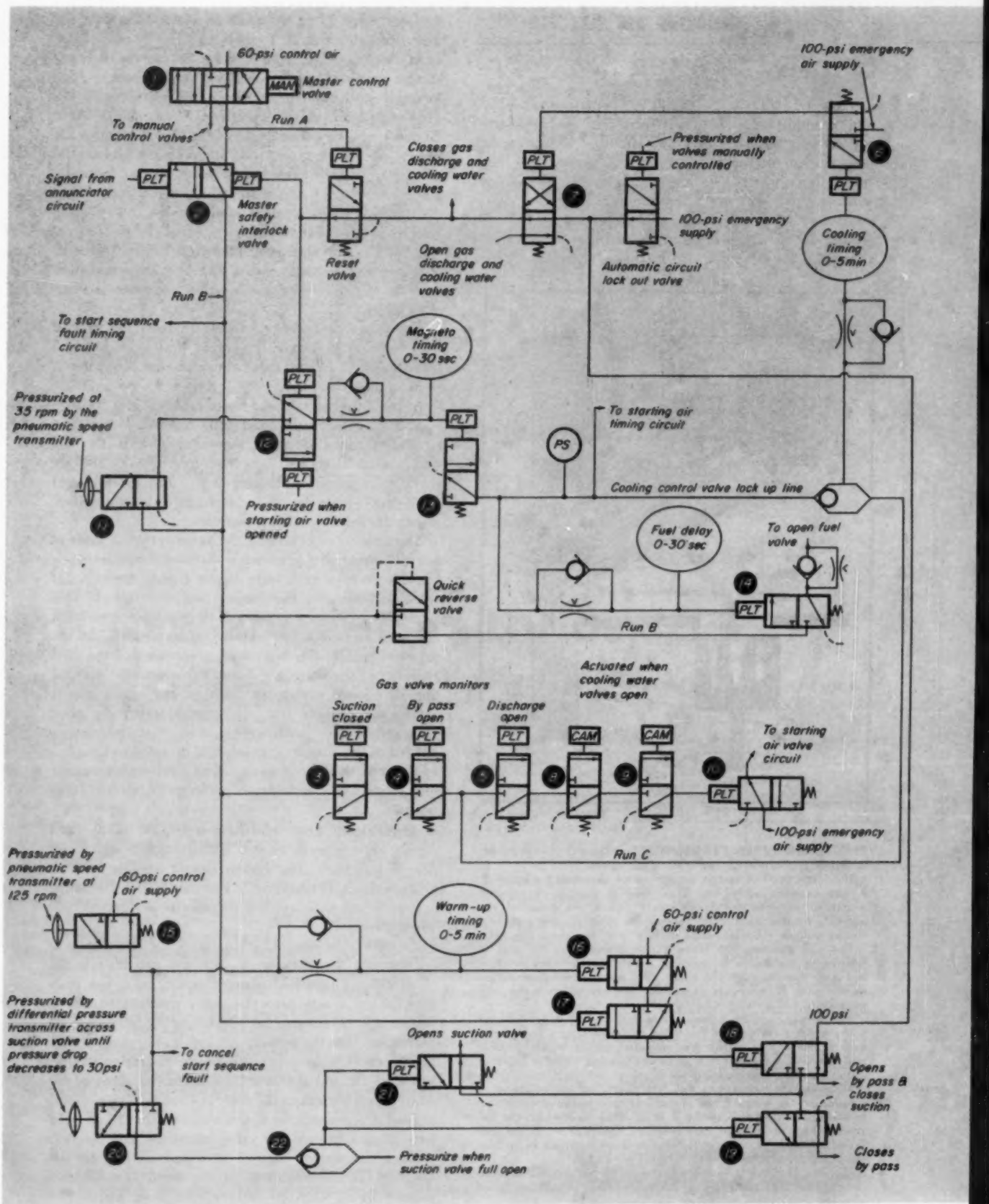
• **Main Sequencing Circuit**—The main sequencing control circuit is essentially a series circuit of pilot operated valves that provide the main sequencing steps, permitting each step to proceed only if the previous step has been correctly completed. Signal lines from sub-sections provide pilot pressures to open controlling valves in this circuit.

When the master control valve supplies air pressure to the RUN A line, it can pass further along the circuit only if the master safety interlock valve permits. This insures a green board before a starting sequence can proceed any further. If the air signal is passed thru valve 2, it then proceeds to pass through valves 3 & 4, which indicate the gas suction valve closed and the bypass valve open. If these conditions are true, the gas discharge and cooling water valves are opened by valves 6 & 7, opening valve 5 and cam operated valves 8 & 9, which permit the RUN signal to proceed and trigger the starting air circuit control valve 10.



PNEUMATIC STROKE COUNTER slow-rolls the engine when starting. It directs air through a small valve, bypassing the main starting air valve. After a set number of strokes (0 to 15) a pilot valve shifts and opens the 2-in. main starting air valve.

MAIN SEQUENCING CONTROL CIRCUIT uses interlocks to prevent functions occuring out of order. If the entire sequence is not completed in a set time, the circuit shuts down the compressor.


60-psi control air
Master control valve
MAN
To manual control valves
Run A
Signal from annunciator circuit
PLT
Master safety interlock valve
Reset valve
Closes gas discharge and cooling water valves
Open gas discharge and cooling water valves
Pressurized when valves manually controlled
100-psi emergency supply
Automatic circuit lock out valve
Cooling timing 0-5 min
Run B
To start sequence fault timing circuit
Magneto timing 0-30 sec
Pressurized at 35 rpm by the pneumatic speed transmitter
Pressurized when starting air valve opened
PS
To starting air timing circuit
Cooling control valve lock up line
Fuel delay 0-30 sec
To open fuel valve
Quick reverse valve
Gas valve monitors
Actuated when cooling water valves open
Suction closed
By pass open
Discharge open
CAM
To starting air valve circuit
Run C
Pressurized by pneumatic speed transmitter at 125 rpm
Warm-up timing 0-5 min
Pressurized by differential pressure transmitter across suction valve until pressure drop decreases to 30psi
To cancel start sequence fault
Opens suction valve
100psi
Opens by pass & closes suction
Closes by pass
Pressurize when suction valve full open

INTERLOCKING AIR CIRCUITS

When signalled by the engine speed sensing valve 11, and permitted by interlock valve 12, the sequence proceeds by shifting valve 13. The ignition system is ungrounded by the pressure switch, the starting air timing circuit initiated, and the fuel valve opened by shifting valve 14, after a time delay through the flow control valve. At full engine speed, sensing valve 15 is shifted to initiate the warm-up period. At warm-up time-out, control valve 16 is shifted and air flows through valve 17 to the pilot on valve 18 calling for flow through valve 19 to close the gas by-pass valve.

At this time, a large differential across the gas suction valve is signalled by pilot output from the differential pressure transmitter to interlock valve 20. This valve holds valve 19 shifted through shuttle valve 22 and stops the suction valve OPEN signal at valve 21. The by-pass valve closes until the pressure differential across the suction valve drops below 30 psi, dropping transmitter output and releasing valves 19 & 21. Now, the OPEN signal goes to the suction valve, but valve 19 releases the by-pass valve CLOSE signal. When the suction valve is fully open, the OPEN signal shifts valves 19 & 21 through shuttle valve 22. The by-pass valves closes completely, and the starting sequence is completed.

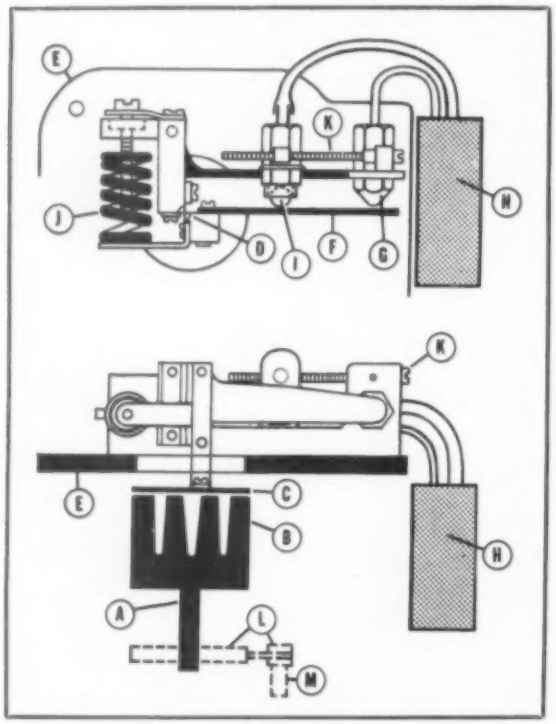
The stopping sequence releases all relay valves with the exception of the cooling period timing valve 6 and relay valve 7. When these time-out, the sequence is complete.

In the main sequencing control circuit air pressure signals the RUN condition and the removal of air pressure signals the stopping sequence. This is the fail safe feature designed into the circuit. Also, the air pressure required in the circuit to control the timing of the cool down period is placed into the timing reservoir during the starting sequence.

The method of obtaining the various timing circuits are all similar. Air pressure is directed through an adjustable flow control valve into a timing reservoir of calculated size for the timing period involved. This same air pressure acts against the spring return pilot operator on a normally closed, 3-way valve. As air pressure builds up in the timing reservoir and the pilot chamber of the valve, the 3-way valve stem is deflected until it crosses center lap position and opens supply air to the delivery line. To provide relatively good snap-action and positive operation, this delivery is not fed to the circuit; instead, it is directed to the pilot operator on another 3-way or 4-way valve which opens immediately and quickly to perform the circuit functions.

• **Operation and Maintenance**—All valves and equipment are prelubricated with a graphite or molybdenum lubricant. The system should operate for two years without dismantling any of the devices. Since the system is self policing, maintenance is performed only when required.

To check the circuit, a simulator for the system is connected to quick-connect couplings provided in the main cabinet manifold plate. The simulator has pressure gauges, 3-way petcocks, and a pressure regulator. When it is connected, no actual engine functions are performed, but the sequencing and monitoring circuits can be checked in detail. All engine operating devices are shut off and the simulator takes the place of the engine with respect to the control circuits. The pressure regulator simulates the speed sensing circuit and pressure gauges replace the valve actuators. The petcocks replace the engine signals provided during the sequences. The simulator is all contained in a portable cabinet 24 in. wide, 30 in. long and 10 in. high. ▼▼▼



Courtesy The Foxboro Co.

PNEUMATIC SPEED TRANSMITTER delivers 3 to 15 psi air in direct proportion to the input shaft speed.

The input shaft ***A*** carries an eight-pole permanent magnet ***B***. A non-magnetic alloy disc **C** is held in position by flexure mounts ***D*** between the keeper plate ***E*** and the poles of the magnet. As the input shaft rotates the magnet, the magnetomotive pull on the disc tends to turn it in the same direction.

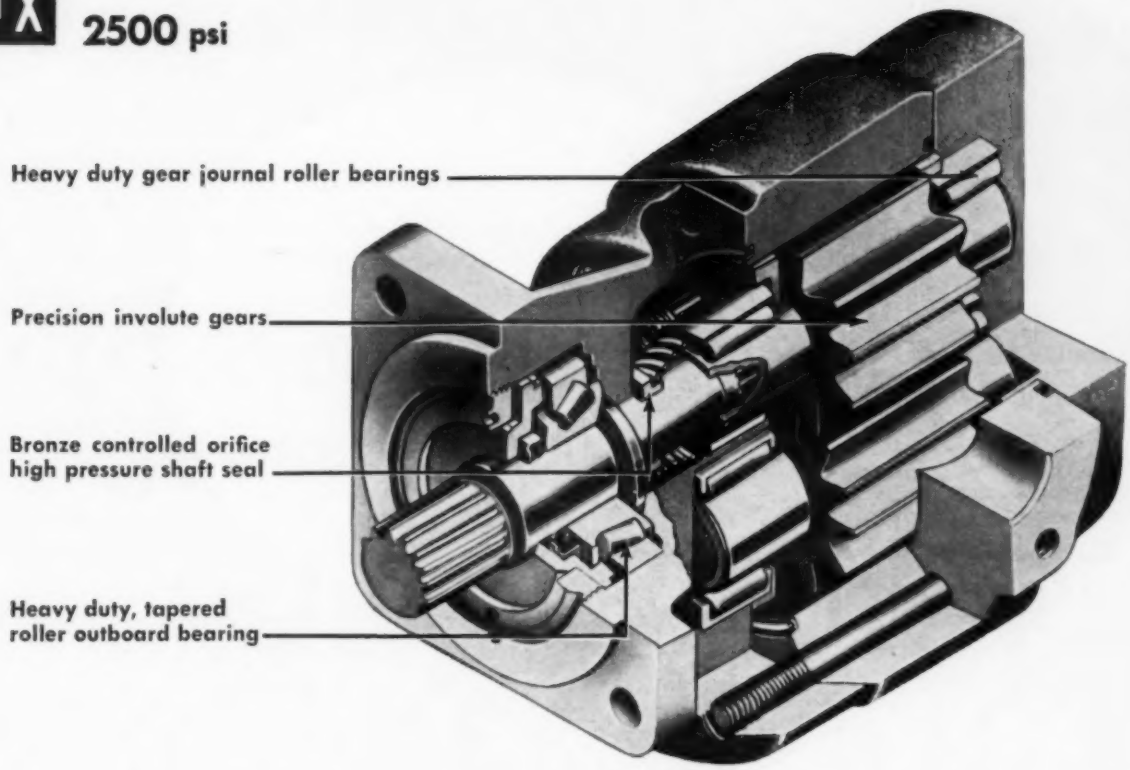
This pull positions the force bar ***F*** attached to the disc in relation to the nozzle **G**, causing an increase in back pressure in the air flow through the nozzle. This back pressure, amplified by the relay ***H***, produces an out-put pressure which is the 3-15 psi transmitted air signal.

The output pressure is also connected to the ball feed-back unit ***I*** which rides against the force bar producing a moment to balance the torque on the disc produced by the magnetomotive pull. The feed-back unit is a small open-ended cylinder in which a ball acts as a free floating piston.

Since the magnetomotive pull is proportional to the speed of rotation of the magnet, the output pressure is also proportional to this speed. The zero spring ***J*** is adjusted to produce the desired output pressure at zero rotation. The relation of the ball feed-back unit to the axis of the disc is determined by a fine-range adjustment screw **K**.

Greater changes in range may be made by a series of fixed ratio drives **L** between the input shaft A and the integral speed changer input shaft M.

37X **2500 psi**


Heavy duty gear journal roller bearings
Precision involute gears
Bronze controlled orifice high pressure shaft seal
Heavy duty, tapered roller outboard bearing

ALL NEW PUMP—150% LONGER LIFE

Now Available—All new heavy duty COMMERCIAL constant displacement pump, Model 37X...recommended for 2500 psi continuous duty operation ... sizes deliver from 11 to 56 gpm. Life expectancy better than 2:1 over previous models. Very simple is its breakthrough success secret ... advanced design, new specification standards, rare craftsmanship and superior performance.

New Inboard Bearings—Entirely new extra heavy duty crown roller bearings have been designed specifically for Model 37X pumps. These bearings have a B10 life increased up to 800% ...are less susceptible to internal contamination than previous models.

All New Gear Design—Gears have fewer, deeper cut teeth ... pump discharge volume per inch of gear width is upped 50%.

Automatic Lubrication—New, nonrotating floating shaft seal automatically meters oil through orifice from pump to heavy duty outboard bearing. Manual lubrication eliminated—result: longer bearing life.

Your Benefits:

1. You can design for higher pressure hydraulic circuitry for faster operation of your equipment.
2. Your fluid power generator will be more dependable, require less maintenance, have greater life expectancy.
3. Plus, the freedom of COMMERCIAL's exclusive "COMPONENT GROUPED DESIGN" retained to permit tandem assembly up to 6 pumps on one shaft; total gear width not to exceed 6 in.
4. A competitive edge to meet today's more demanding performance required of your heavy duty construction, mining, materials handling, agricultural or ground support equipment.

Model 37X pumps are furnished with standard gear widths ½", 1", 1½", 2" and 2½".

performance data (per inch of gear width)

	delivery (gpm)		
speed rpm	500 psi	1500 psi	2500 psi
600	7	6	6
900	11	11	10
1200	16	15	15
1800	24	23	23

	input (hp)		
speed rpm	500 psi	1500 psi	2500 psi
600	3	7	13
900	4	11	19
1200	5	16	26
1800	6	23	38

Free bulletin gives mounting, piping and shaft data. Address: Commercial Shearing & Stamping Company, Department A-40, Youngstown 1, Ohio.

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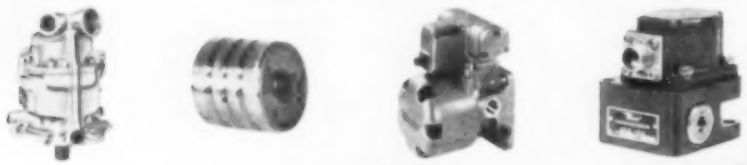

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SECOND PRIZE

GEORGE F. FLING, *Applied Systems Design Engineer,*
and GRADY GILDER, *Applied Systems Design Engineer,*
Chance Vought Corp., Dallas, Texas

Techniques for designing airborne components

Temperature, pressure, shock, and flow forces are important factors in component reliability. Here's the results of research conducted to establish the relationships among these factors.

A RECENTLY COMPLETED research program to develop modular hydraulic concepts, included development, fabrication, and test of thirty-three different hydraulic components. The cartridge components were designed for packaged, airborne hydraulic systems operating at 4000 psi with fluid temperature ranging from —65F to 450F in an ambient of —650F. The fluid was MLO 8200.

The components had to be self-contained for easy replacement, and made of corrosion resistant materials.

SEALS

Metallic seals were required because of the high operating temperature. Several commercially available seals were evaluatd before one was selected for use in the high temperature hydraulic components. However, seal leakage was a frequent problem in developing these cartridge components. Using metallic seals requires a re-education in designing, fabricating, and handling seal installations.

Surface finish of parts in contact with the seal, and the amount of squeeze put on them must be controlled more closely for metallic seals than for elastomeric seals. The force required to compress a metallic seal is relatively high; therefore, component assemblies should be designed for proper seal squeeze when parts bottom out on each other. Torque should not be the criterion for proper compression of the metallic seals. With close attention to the details of manufacturing and assembly, excellent results can be obtained with several types of metallic seals now available.

PRESSURE BALANCING

Slider seizure was a problem in valve design. This was caused by a difference in pressure between the inside and the outside of the cartridge body. Some component bodies contracted as much as 0.002 in. at operating pressures. The most effective method of overcoming this problem is through proper location of the seals with respect to spool lands (Figure 1). This should either eliminate unbalance or keep it in the direction to increase rather than decrease clearance.

HYDRAULIC LOCK

In several selector valves, hydraulic lock caused the slider to hang in one position. Hydraulic lock is a relatively high, static friction force which is produced by pressure acting on one side of the slider, forcing it against one wall of the valve body. The force, normal to the axis of the slider, may be reduced by the addition of labyrinth grooves in the slider. Many manufacturers design valve spools without groove in the lands. The grooves are added only if hydraulic lock occurs. This is probably because the research work about hydraulic lock is not widely known. Some experimental work has been done to determine the variation of breakout force with the number of the grooves.[1]

A quantitative theory of the pressure distribution and the resulting land force has also been developed.[2] Some designers add grooves to reduce leakage rate. The theory is that grooves help keep the spool concentric within the valve body. Other designers dispute this, and there seems to be little evidence to support

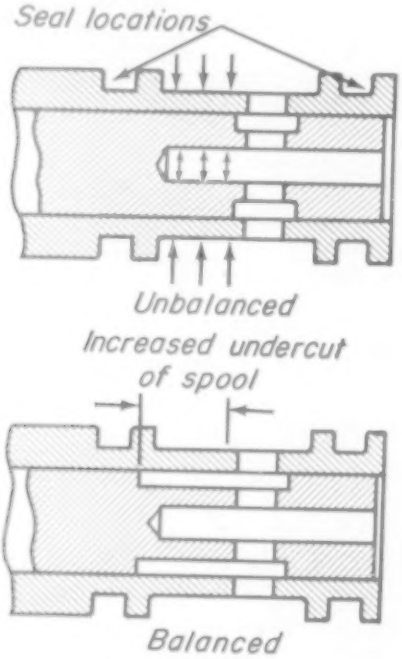

FIG. 1. UNBALANCED PRESSURE causes valve spool to seize. Undercutting the spool equalizes pressure and allows the spool to move freely.

the theory that labyrinth grooves reduce leakage rate of an incompressible fluid.

PREVENTING GALLING

Galling and seizure of lapped assemblies is sometimes caused by contaminant wedged into the clearance between the spool and valve body. Spool lands should have sharp corners to prevent this.

BLIND LAPS

Some components in which the female part is designed as a blind lap do not allow enough room for the lead taper on the lapping tool. There is leakage because the valve spool cannot reach shutoff position. Blind laps are satisfactory where a relief is provided on either the spool or the bore as shown in Figure 3.

LEAKAGE

Leakage rates can be calculated from component design. The equation for leakage through an annular flow path shows that leakage varies inversely as the absolute viscosity of the fluid:

$$Q = \frac{\pi D\, b^3 \left[1 + 1.5 \left(\frac{E}{b} \right)^2 \right] \left[Pu - Pd \right]}{12\, \mu\, L}$$

where μ = fluid viscosity, lb. sec./sq. in.
Q = volume flow rate, cu. in./sec.
D = diameter of passage, in.
b = passage height, in.
Pu = upstream pressure, lb./sq. in.
Pd = downstream pressure, lb./sq. in.
L = passage length (in direction of flow), in.
E = eccentricity of spool within sleeve, in.

The kinematic viscosity of MLO 8200 fluid is approximately 35 centistokes at 90 F, and 3 centistokes at 450 F. The density is approximately 0.925 gms/cc at 90 F and 0.765 gms/cc at 450 F.[4] Using these values, the absolute viscosity is 34.8×10^{-5} lb. sec/sq. in. at 90 F and 2.47×10^{-5} lb. sec/sq. in. at 450 F. The viscosity change corresponding to this temperature change is in the ratio 14 to 1. The equation shows that leakage rate will be approximately 14 times as great at 450 F as at 90 F. In practice, leakage rate does not change according to calculations. In tests of lapped valves, leakage rate at 450 F has been from 1 to 2.5 times values recorded at 90 F. The values of viscosity given above are for atmospheric pressure. Pressure as high as 4,000 psi alters the viscosity, but no data is available. Also, length of the waiting period before measurement is begun greatly affects the measured rate. Even in well filtered systems, enough silting occurs at high temperatures to decrease leakage. The amount of contaminant in the system will thus affect leakage rate of a lapped hydraulic valve.

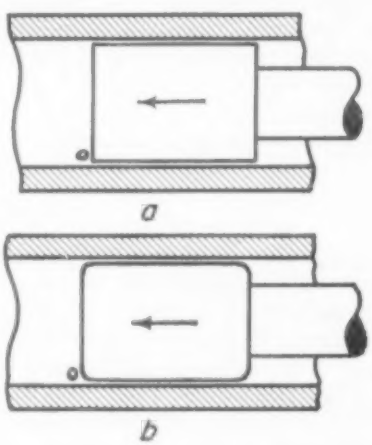

FIG. 2. SHARP EDGES on spool at top prevent particles larger than about 5 microns from getting between the spool and body. Radius on spool at bottom wedges particles into clearance, causing galling.

WEAR

Certain combinations of materials and surface treatments have been successful in the slider and body mak-

ing up a lap assembly. Some of the combinations having good wear resistance in qualification tests are listed in the table.

Body And Slider Stainless Steels Which Give Good Wear In a Lap Assembly

Body Material	Plating	Slider Material	Surface Treatment
17-4PH	None	17-4PH	Nitrided
17-4PH	None	17-4PH	Tungsten carbide
416	None	440C	Chrome
440C	None	440C	Chrome
440C	None	440C	Tufftride
440C	None	440C	None

Some components developed in this program use an unplated stainless steel against a stainless steel which was neither plated nor case hardened. In several cases this was successful, but it is not recommended for lap assemblies which operate in a fluid having relatively poor lubricity. Bare lap assemblies sometimes failed from galled parts or hydraulic lock of the mating parts. Side loads, created by imperfect parts, flow forces, detents, or contamination also cause galling or hydraulic lock. Unplated assemblies have been very satisfactory for valves with clearances of 0.001 to 0.002 in.

DIMENSIONAL STABILIZATION

Three valves definitely failed because of dimensional changes in the finished parts, and it is suspected that this was the cause of other failures. An adequate stabilization procedure should be contained in each component manufacturer's heat treatment specification. Each of the three valves had one or both parts making up the lap assembly made from 440C. The Metals Handbook, in discussing martensitic stainless steels, says "The higher-carbon martensitic grades such as 440C are likely to retain large amounts of untransformed austenite in the as quenched structure, frequently as much as 30% by volume. Stress relieving at 300 F has little effect, since higher temperatures are required to achieve transformation. Delayed transformation may occur as a result of temperature fluctuations in service, thus resulting in embrittlement and serious dimensional changes. A portion of this retained austenite may be transformed by subzero cooling to about —100 F immediately after quenching. If some decrease in hardness can be tolerated, the steel should be stress relieved at a higher-than-normal temperature, preferably near 700 F. Two complete cycles of stress relieving are advisable, regardless of the temperature used. In combination with the high stress-relieving temperature, the subzero treatment is less useful, although both treatments are recommended for maximum stability. In general, the high-carbon grades should be tempered at a temperature at least as high as that to which they will be subjected in service."[5]

A number of the manufacturers participating in the program subject their parts to three complete stabilization cycles. The recommended manufacturing sequence for unplated parts made of 440C is: (1) Machine parts to within about 0.002 in. of finish dimension; (2) Heat treat (Harden, quench, three heat cycles from cold stabilization temperature to tempering temperature); (3) Finish grind; (4) Bake 4 hours and; (5) Finish lap.

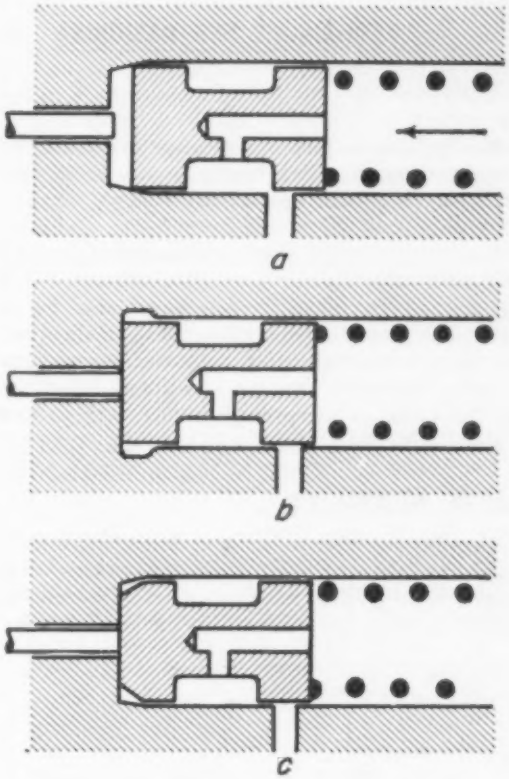

FIG. 3. BLIND LAPPING leaves a taper on the valve body (a). This stops the spool before it reaches the end of its stroke. To allow full spool movement, either the body or the spool must be relieved as in (b) and (c).

SOLENOID DESIGN

Manufacturing acceptable solenoids has been a sizeable problem. They are required to operate in an ambient temperature of 650 F and use a ceramic coated wire. The wire withstands a continuous operation at 650 F, but the ceramic insulation is brittle and tends to flake off, if the solenoid is not carefully wound and handled. Some solenoid windings terminate with the wire brazed directly to the connector. Others use a lead wire to join the solenoid and connector. One type of lead wire is Teflon insulated with a silicon fiberglass cover. Di-electric breakdown occured on some solenoids because of careless winding.

EFFECT OF TEMPERATURE ON PRESSURE SETTING

Operation of some components over a wide temperature range caused a slight change in their characteristics. Spring-loaded valves such as relief valves had a slightly lower cracking pressure at 450 F than at 95 F. The coefficient of elasticity of Inconel X and 17-7 PH stainless steel, from which the springs are made, decreases as temperature increases over this

range. The bourdon tube in a pressure switch had the same characteristic. The pressure at which the electrical contacts open is approximately 50 psi lower at 450 F than at 95 F.

Most systems do not require compensators, but if a relief valve must open at a constant pressure over a wide temperature range, a compensator may be included. This usually consists of installing an aluminum part, or other material which has a higher coefficient of thermal expansion than the adjacent steel parts, so that the spring is compressed farther at high temperature.

VALVE STABILITY

Instability has been a factor in developing thermal relief valves, pressure relief valves, and priority valves. Rated flow for thermal relief valves has been increased from 15 cc/min. to 0.1 gpm. This increased flow has

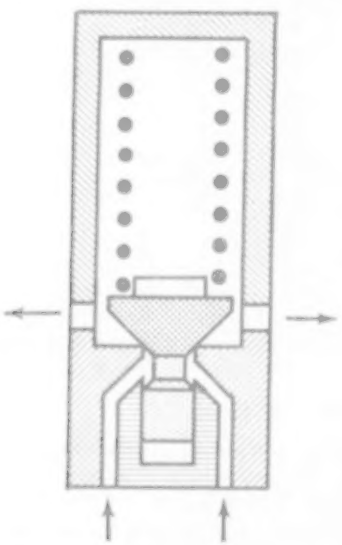

FIG. 4. DIRECT OPERATED RELIEF VALVE has damping piston attached to its poppet. Piston clearance determines the relation between valve stability and damping.

also increased valve instability. Some experimental work was done to determine the amount of damping required to overcome the instability. A mass-damper analysis can be applied to any direct operating relief valve, so that the valves viscous damper provides a damping factor ratio C/C_c between 0.5 and 1.0,

where C = damping constant
C_c = critical damping factor, $2\sqrt{mk}$
m = mass of poppet and damping piston
k = spring rate of spring

Direct operating relief valves developed in this program were stabilized with a damping piston. The clearance between the damping piston and the damping chamber was initially made small to produce a valve which was stable but sluggish. The clearance was then increased in small increments until a satisfactory compromise between response and stability was obtained.

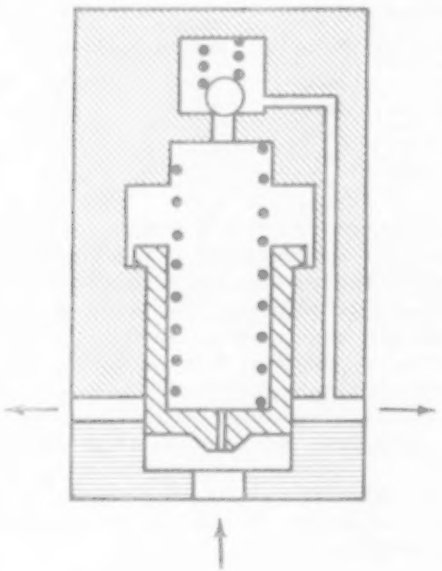

FIG. 5. PILOT-OPERATED RELIEF VALVE is stabilized by placing the poppet orifice in a projection extending into a non-turbulent flow stream.

The pilot-operated valve presented another set of problems. The pilot stage by itself functions just like a direct operating relief valve. It is subject to instability if too high a flow rate is passed through the pilot stage. Also, the location of the restriction within the

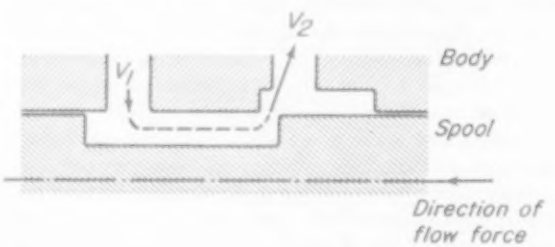

FIG. 6. FLOW FORCE on a valve spool is directly proportional to fluid outlet velocity minus inlet velocity. This force may be reduced by enlarging the flow passages or changing the angle at which fluid enters and leaves the spool groove.

main stage slider or poppet is very critical. If it is in a region of turbulent flow, the valve remains unstable. Therefore, the main slider was modified so that a projection containing the orifice extends into the less turbulent flow stream.

A priority valve similar to the pilot-operated relief valve was also unstable. It was stabilized by adding a flow limiter to the pilot stage.

FLOW FORCES

Axial forces on a valve spool are created by fluid flowing through the valve. This force can be calculated from the change in momentum of the fluid between inlet and outlet of the valve, using the equation

$$F = Q\,p\,(V_2 - V_1).$$

Where p = fluid density, V_2 = exit velocity, Q = flow rate, F = flow force, V_1 = inlet velocity

In this equation Q and p are scalar quantities while F and $(V_2 - V_1)$ are vector quantities. From the equation it can be seen that flow force increases as flow rate increased. The 25 gpm valves which were developed had higher flow forces than the 4 or 12 gpm valves. This must be considered in designing components such as pressure-operated, shut-off valves which must open and close within a narrow actuation pressure range.

Flow forces may be greater than the force available for positioning the slider. They can be reduced by several methods. Fluid velocity can be reduced by providing a larger flow area with resulting decrease in the flow force. Since $V_2 - V_1$ in the above equation represents a vector subtraction, the magnitude may be reduced by changing the angles at which fluid enters and leaves the slider groove. In 4-way valves two opposing forces may be made to cancel each other. An analysis of axial forces along valve spools and experimental work to support the analysis has been made by Dr. Lee and Dr. Blackburn.[6]

THERMAL SHOCK

Tests on 4-way, 3-position selector valves (one cartridge and one face-mounted) have shown that thermal shock can cause malfunction. The valves tested performed satisfactorily in a rapid warm up test. However, if fluid 100 F hotter than the valve is suddenly introduced, the valve spool expands more rapidly than the valve body. It seizes within a few cycles as alternate solenoids are energized. The valve functions normally when temperature stabilizes throughout the valve.

A valve with increased clearance also seized, so failure from rapid expansion can not be eliminated by increased clearance while still maintaining a reasonable leakage rate. This situation is typical of many sleeveless valves and valves in which the sleeve is shrink-fitted into the valve body. In low temperature valves, there is no problem where the sleeve is designed to float in O-rings.

ORIFICE PROTECTION

During development testing, the main poppet of a 25 gpm relief valve would open and pass rated flow under low pressure, very much like a check valve in the free flow direction. This was caused by partial clogging of the screen which protects the 0.015-in. orifice to the pilot stage. When the screen was thoroughly cleaned, the valve functioned properly. The filter screen had an absolute, 20-micron rating, which is better than required in this application. Specification MIL-H-5440 requires that all orifice holes smaller than 0.070-in. diameter in flow regulators and restrictors be protected by a filter element having a screened opening of 0.008 in. to 0.012 in. Most valve manufacturers use a filter to protect the orifice in valves other than restrictors and flow regulator. However, they sometimes use a screen which does not conform to the above dimensions. The requirement for a screen with a 0.008 in. minimum opening should apply to such pilot-operated valves as relief valves, priority valves, and solenoid-operated, selector valves. Too fine a filter will clog and defeat its purpose.

FILTER ASSEMBLY DIFFERENTIAL PRESSURE INDICATORS

The indicator in a filter assembly senses the differential pressure between the upstream and downstream sides of the filter element. In the indicators of this program, differential pressure acts on a piston until net force overcomes a spring. A red indicator button then pops out. Most indicators for low temperature applications use elastomers as dynamic seals on the sensing piston. Qualification of a high temperature indicator utilizing reed seals as a dynamic seal was attempted on a 4-gpm filter. While this provided no initial leakage and a low leakage rate after endurance cyling, the design could not be considered satisfactory because of external leakage. The indicators which have ultimately been qualified in the 4, 12, and 25 gpm filters were magnetic types in which both the indicator button and the actuating piston are permanent magnets separated by a thin steel wall. No external dynamic seals are required. An internal dynamic seal is used on the sensing piston.

FILTER WASHOUT

Much effort was spent in developing a filter for use within restrictor valves. All orifices smaller than 0.07 in. in diameter must be filtered. These filters repeatedly failed during erosion test in which flow, sufficient to maintain a 5000-psi differential pressure, is passed through the orifice. Several types of wire cloth were used. An acceptable valve was finally created by using baffle plates to disburse the flow and reduce the maximum local velocity through each filter. ▼▼▼

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2. J. F. Blackburn, G. Reethof, and J. L. Shearer, *Fluid Power Control* (New York: Wiley and Technology Press of M.I.T., 1960), pp 279-289.

3. *Ibid.*, p. 58.

4. N. W. Furby, R. L. Peeler and R. I. Stirton, "Oronite High-Temperature Hydraulic Fluids 8200 and 8515," *A.S.M.E. paper No. 56—AV-22* (New York: A.S.M.E., 1956), Figs 3, 4.

5. American Society for Metals, *Metals Handbook*, ed. Taylor Lyman (8th ed; Novelty, Ohio: American Society for Metals, 1950), Vol I, p 419.

6. S. Y. Lee and J. F. Blackburn, "Axial Forces on Control —Valve Pistons," *Meteor Report No. 65*, (M.I.T. 1950).

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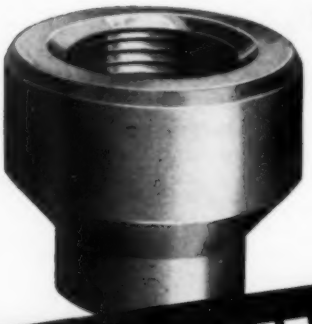
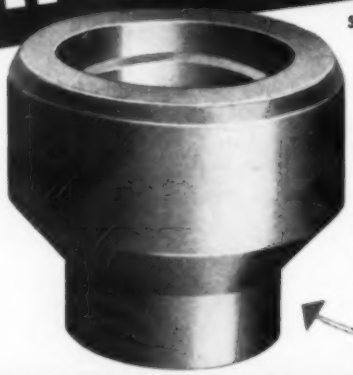


THREADED TYPE

FORGED STEEL WELD COUPLETS



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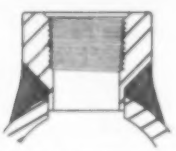
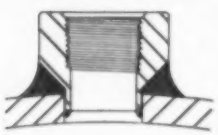


Small Diameter Pipe



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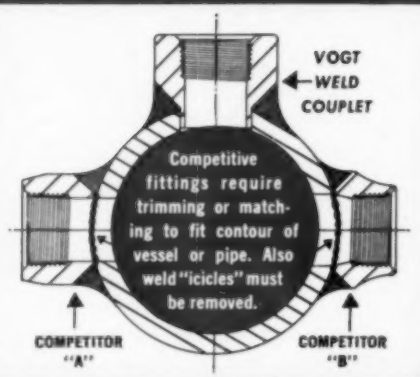
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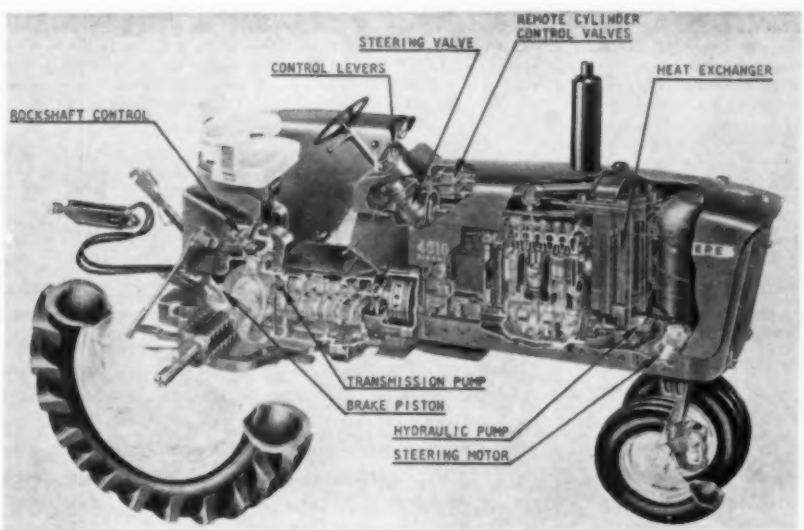
Closed circuit system powers tractor's hydraulics

A variable displacement pump in a closed center system supplies the power required to operate this tractor's hydraulic equipment. The one-pump design saves space, horsepower, and costs.

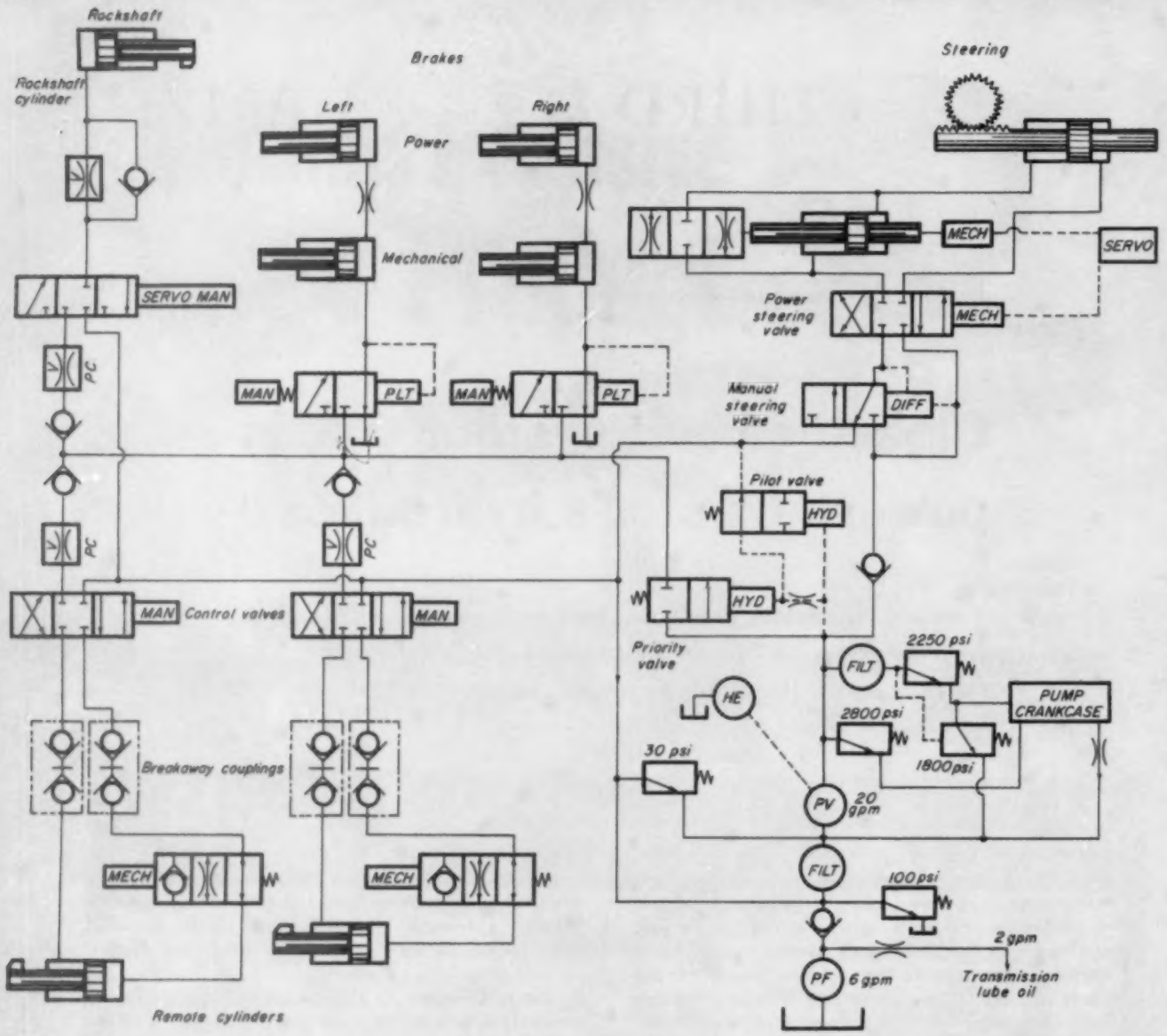
TRACTORS come equipped with a variety of hydraulic equipment. Agricultural tractors may have power steering, power brakes, a rockshaft, and one or two remote cylinders. An industrial tractor may carry a loader, backhoe, winch, mower, or saw. Many tractors require two or three pumps, reservoirs, and filters to power these attachments. However, multiple hydraulic components, take up more space, waste horsepower, and are costly.

The closed center, constant pressure, hydraulic system used on John Deere 3000 and 4000 series tractors provides a versatile circuit that can handle any of these operations with a one-pump drive, and avoid excessive loss of horsepower.

• **Pump Design**—An eight-piston, variable displacement, crankshaft-driven pump supplies 20 gpm at 1900



TRACTOR HYDRAULIC components are integral part of machine. Rockshaft components are part of transmission housing. Steering valve is under control dash. Steering motor is part of front wheel spindle assembly.



SMALL, LOW PRESSURE, fixed displacement pump in the transmission housing delivers 6 gpm at 100 psi maximum at rated 1900 rpm engine speed. About two gallons are bled off to provide positive lubrication to the transmission, even at low engine speed. When the hydraulic system is in neutral, the remaining four gpm are circulated through the filter, main pump inlet manifold, the heat exchanger, and back to the transmission housing. This circuit filters the oil and supercharges the main pump to prevent cavitation or pump starvation. It also stabilizes the oil temperature in the transmission, lubrication, and hydraulic systems. A relief valve set at 30 psi by-passes the oil filter when pressure-drop across the filter exceeds 30 psi. Another relief valve limits pressure in the re-circulating circuit to 100 psi. Most of the return oil is recirculated to the main pump through this circuit. A small quantity is continually bled off from the main pump and cooled in a heat exchanger.

rpm and full displacement. The eight radial pistons are spring-loaded against a single, eccentric cam as shown in Figure 1. The pump's inlet and outlet valves are spring-loaded poppets designed to hold valve weight and turbulence to a minimum.

System pressure is held between 2000 and 2250 psi by varying pump displacement to meet the flow requirements of each hydraulic operation. The pump delivers 19 gpm at 2000 psi and zero flow at 2250.

Pump displacement is controlled by varying the pressure in the pump crankcase, Figure 2. Varying the pressure overcomes the force of the pump's pistons so that only enough oil is pumped to meet any specific demand. The relief valve in the pump's output line controls oil flow *into* the pump crankcase. A fixed orifice and a spool valve control oil flow *out of* the pump crankcase. Approximately one half gpm flow through the crankcase is required to hold the pump out of stroke at 2250 psi.

• **Power Steering Servo System**—A priority valve

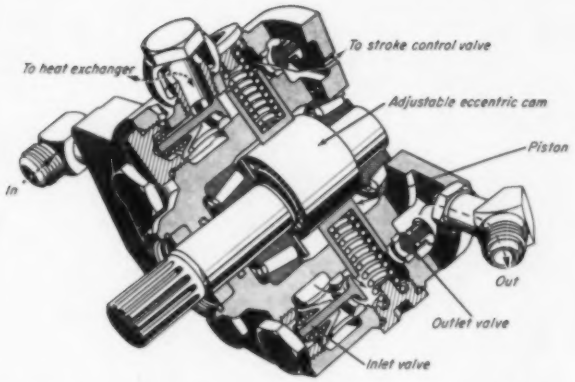


FIG. 1. RADIAL PISTON PUMP has eccentric cam to stroke eight, radial, spring-loaded pistons.

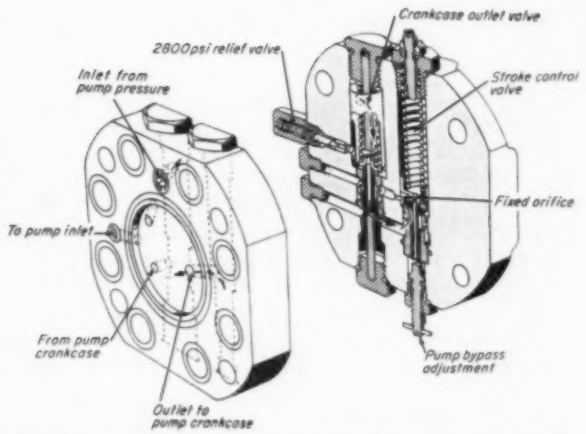


FIG. 2. SYSTEM PRESSURE is maintained by varying pump displacement. Valves in pump control displacement by varying pressure in pump crankcase.

The nut of the worm-and-nut servo assembly is mounted on the piston rod of the feedback cylinder. There is no pressure feedback, and shocks in the front wheels are not transmitted to the steering wheel. This gives the operator uniform steering ease and comfort regardless of front-end weight or terrain conditions.

If, for instance, the steering wheel is turned for a right turn, Figure 5, the worm moves the nut servo downward and makes the two plates pivot about the two dowels shown. Valves 1 and 2 are unseated. System oil flows through valve 5 and valve 1, over valve 3 and to the bottom side of the feedback cylinder. The cylinder actuates the steering motor and the wheels turn to the right. Return oils goes through unseated valve 2 back to valve 5 and to the return line. The manual steering valve changes tractor steering from power to manual at approximately 750 psi.

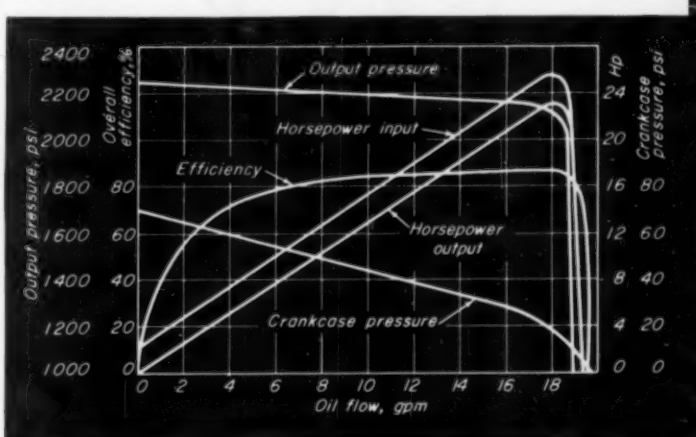
It takes less than 3-¾ lb to produce 16,000 lb-in. torque on the front wheel spindle. There is .030 in. end play in the worm to actuate the control valves. If hydraulic power is not available, turning the steering wheel a little farther moves the nut, on the slave cylinder rod, and the slave cylinder becomes a mechanical linkage for manual steering.

• **Brakes Have Pressure Feedback**—The power brakes operate during the first 2 in. of brake pedal travel. Figure 6 shows the left hand brake being depressed while the right hand brake is being released. The power brake piston provides pressure feedback which gives the operator a braking feeling directly proportional to the push on the brake pedal. Less than 30 lb push produces 100,000 lb-in. braking torque at each rear wheel. If hydraulic pressure is not available, the operator continues to depress the brake pedal which pushes directly against the master cylinder and gives the tractor mechanical braking.

• **Rockshaft Cylinder Is Single Acting**—A closed loop, servo system, shown in Figure 7, controls the rockshaft which raises and lowers hitch mounted implements.

When the control handle is moved forward, it actuates the valve's metering shaft, and unseats the

FIG. 3. LOW STAND-BY HORSEPOWER and flat over-all efficiency curves were major design objectives of tractor pump. Volumetric efficiency is 95%. Maximum overall efficiency is 88%.



in the pressure line directs flow to the steering circuit as shown in the circuit diagram and Figure 4. This pilot-operated check valve closes and blocks flow to the rest of the hydraulic system whenever pressure drops below 1800 psi. The steering control valves, worm-and-nut servo, and feedback cylinder are mounted on the steering column as shown in Figure 5. The steering motor is at the front of the tractor frame and makes up the front wheel spindle. A slave cylinder provides position feedback.

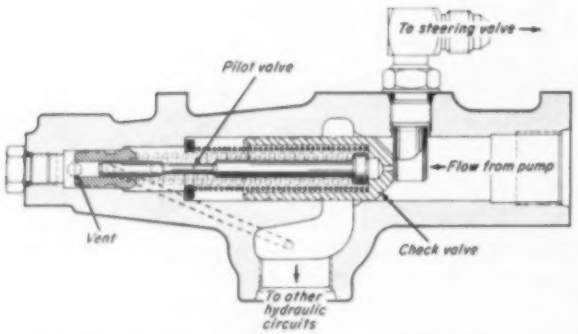


FIG. 4. PRIORITY VALVE is pilot operated and insures uninterrupted pressure to steering circuit. Flow is restricted to tractor's other hydraulic circuits when system pressure drops below 1800 psi.

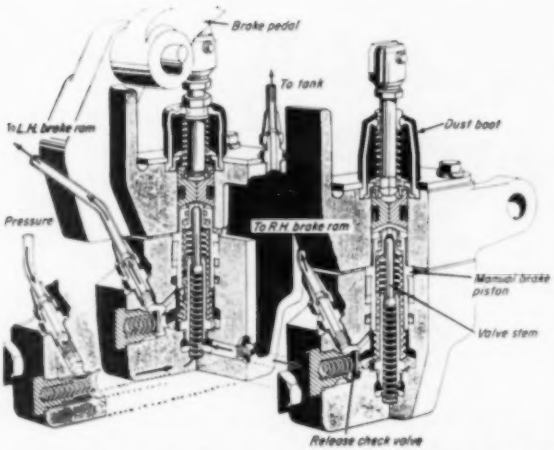


FIG. 6. BRAKE MASTER CYLINDERS operate during the first two inches of pedal travel. Braking force is proportional to push on brake pedal.

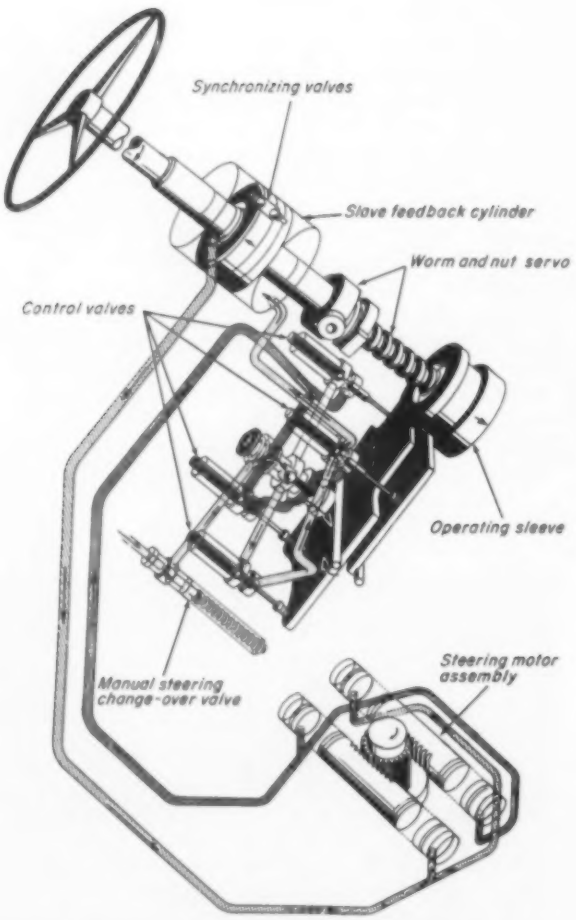


FIG. 5. SERVO FEEDBACK IN STEERING CIRCUIT returns control valves to neutral after front wheels have turned through an angle proportional to turning of the steering wheel angle.

check ball. As long as the following relationship is maintained, in the valve:

$$\frac{\text{restriction at ball seat}}{\text{restriction at orifice}} > \frac{\text{area of valve head}}{\text{area of valve head—area of valve seat}}$$

the outer valve remains closed. Oil is metered through the outer valve and the rockshaft slowly lowers its load as shown in Figure 8. When this ratio is reversed, however, pressure at the head of the valve is reduced, and the outer valve floats off its seat. The rockshaft rises quickly and lifts its load in a few seconds.

The rockshaft cylinder is single acting, and requires only two control valves. An adjustable, pressure-compensated, flow control valve ahead of the poppet control valves, controls the rate of lift of implements regardless of their weight. A variable orifice valve with free reverse flow check valve controls the rate of drop. This is particularly important when very heavy equipment is hitched to the tractor.

• **Servo Feedback Controls Rockshaft**—The rockshaft has two feedback systems, Figure 7. Either can be chosen by setting a selector lever on the side of the rockshaft housing. This moves a roller up and down the cam follower to correspond with the position of the selector lever. In load control position *L*, the load on the draft links is fed back through deflection of the load bar on which the links are mounted. The load bar deflection actuates the feedback linkage and returns the control valve to neutral. The rockshaft raises or lowers the implement according to load change and closes the feedback loop. The position of the rockshaft and load always corresponds to the position of the control lever on the control quadrant.

In depth control position *D*, the position of the hitch is fed back by a cam on the rockshaft. The cam returns the valves to neutral and closes the loop. The depth at which the implement operates is again proportional to the position of the control lever on the

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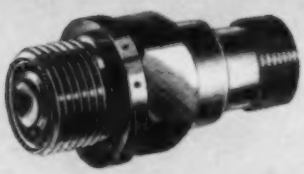

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CLOSED CIRCUIT SYSTEM

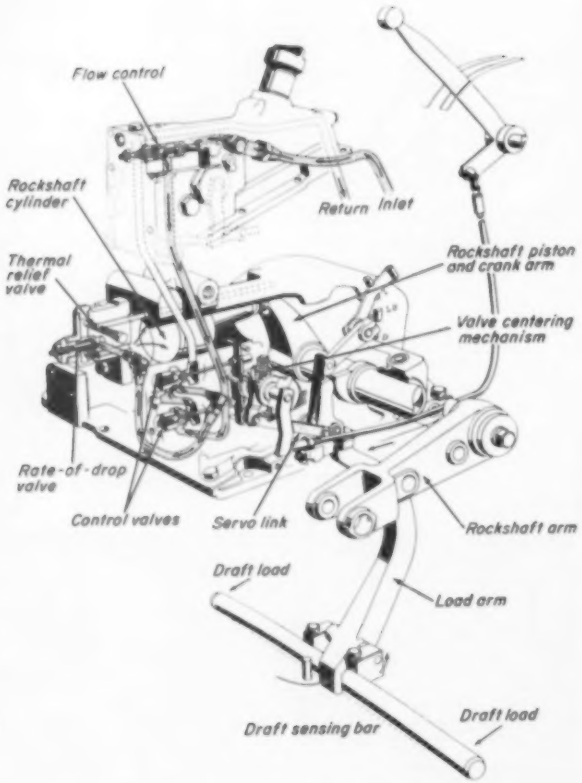

FIG. 7. ROCKSHAFT CLOSED-LOOP SERVO SYSTEM controls hitch-mounted implements. Rockshaft cylinder is single acting. System has independent controls for load and depth.

instrument panel quadrant. A third position of the selector lever provides load and depth control *DL* by feeding back part of each of these signals. The depth at which the implement operates is proportional to the position of the control lever, but is modified by the load on the drag links.

● **Remote Control Cylinders**—The remote cylinder control valve has no servo feedback system. It has a six-position, directional control valve to actuate double or single acting cylinders as shown in Figure 10. A pressure-compensated flow control valve in the pressure line can be adjusted to control flow rate to 12 gpm. The poppet valves are pilot operated and have these operating positions: neutral, slow raise, fast raise, slow lower, fast lower, and float. The control levers are spring returned to neutral when the valves are shifted to the slow speed positions. The levers remain detented in fast speed positions but return to neutral automatically when the remote cylinders reach the end of their strokes. In float position the valves remain detented and must be centered manually. ▼▼▼

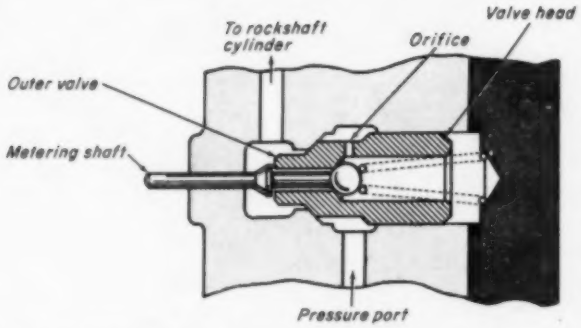

FIG. 8. ROCKSHAFT CONTROL VALVE has metering shaft actuated by control lever on instrument panel. Accurate oil metering lets rockshaft go up quickly, come down slowly.

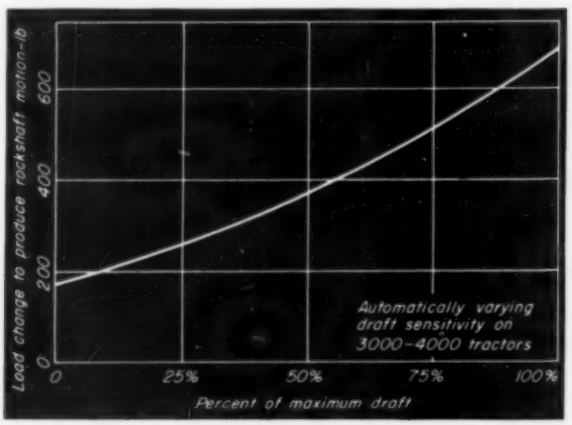

FIG. 9. VARIABLE SENSITIVITY of the load bar which supports the draft links measures the load in them. As load bar bends, leverages change to give greater sensitivity at light draft loads.

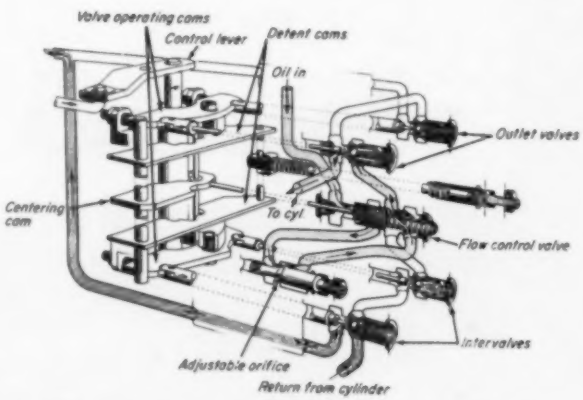

FIG. 10. REMOTE CYLINDER VALVE has no servo feedback system. Six-position, directional control valve controls double or single-acting remote cylinders.

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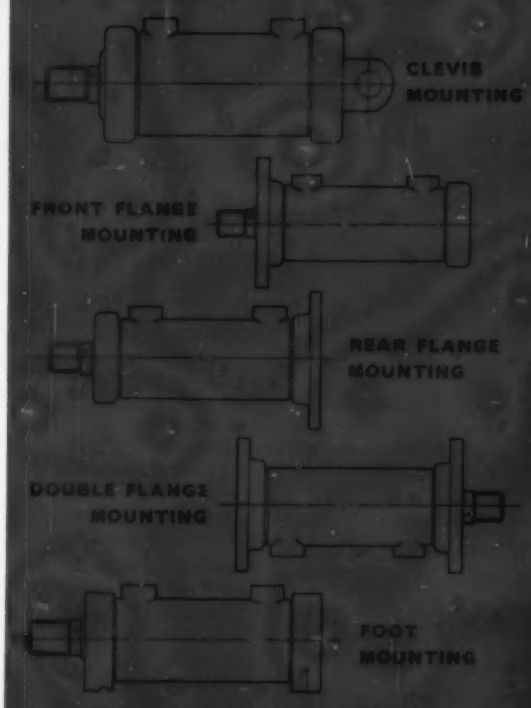

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Bore Dia.	1"	1½"	2"	2"	2½"	2½"	3½"	4"	4"	5"	6"	7½"
Thds.	3060 and A, B, C, or D.	3544 and A, B, C, or D/80	1957 and A, B, C, or D/80	1957 and A, B, C, or D/123	1851 and A, B, C, or D/220	1851 and A, B, C, or D/227	4295 and A, B, C, or D/80	2867 and A, B, C, or D/80	2867 and A, B, C, or D/152	2434 and A, B, C, or D/80	2868 and A, B, C, or D/93	5619 and A, B, C, or D.
Max. Press.	1000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Rod Dia.	½"	1 1/16"	1"	1⅜"	1⅜"	1 13/16"	2"	2"	2½"	2½"	3½"	4"
Bore Area	·7854 □"	1·7671 □"	3·142 □"	3·142 □"	5·94 □"	5·94 □"	8·296 □"	12·57 □"	12·57 □"	19·64 □"	28·27 □"	44·179 □"
Rod Area	·1964 □"	·8846 □"	·785 □"	1·49 □"	1·49 □"	2·948 □"	3·142 □"	3·142 □"	6·492 □"	4·908 □"	8·296 □"	12·566 □"
Annular Area	·5980 □"	·8805 □"	2·357 □"	1·652 □"	4·45 □"	2·992 □"	5·154 □"	9·424 □"	6·072 □"	14·727 □"	19·978 □"	31·613 □"
Max. Stroke	up to 6"	up to 40"	40"	40"	70"	70"	75"	80"	80"	100"	130"	144"

Note: 1. Longer stroke lengths are available for certain applications.
2. Cylinders can be manufactured to specific requirements.
3. Special rods are available.

For full details write to

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Mr. T. P. Keeling,
Keelavite Hydraulics Ltd.,
Pieter de Hoochstraat 17
Rotterdam 6, Holland

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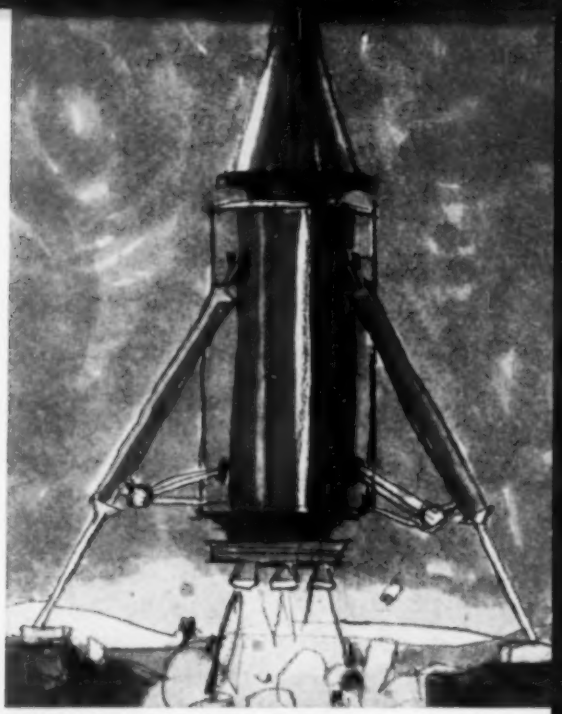
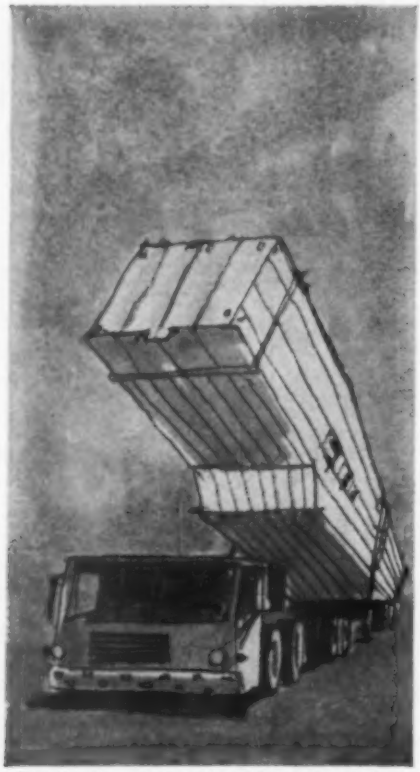
Advanced hydrofoil designs make use of Bendix hydraulic actuators.

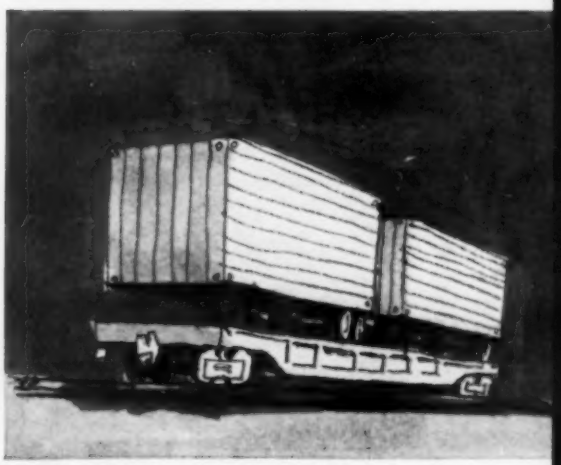


Telescoping shock absorber systems are being designed for lunar landings.

Deep water loading stations employ shock absorbers.



Raising, lowering and positioning missiles with the aid of Bendix hydraulic actuators.



Bendix shock absorbers cut damage claims on railway shipments.

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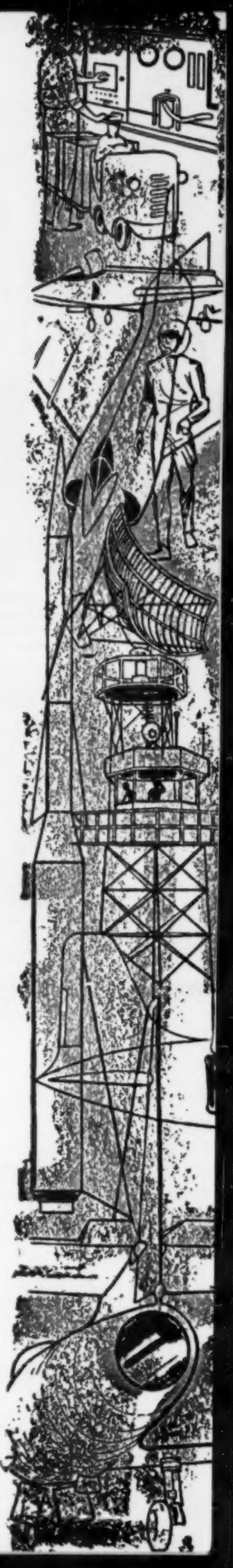
THE Bendix CORPORATION

AEROSPACE SECTION

Fluid Systems For Flight and Ground Support



Aero/Space Hydraulic Conference

A two-day seminar on fluid power applications and systems for missiles, space vehicles, and jet aircraft will be presented by the Aero Hydraulics Division of Vickers Inc. Div. Sperry Rand Corp. This 1961 Aero/Space Fluid Power Conference in Detroit on October 30-31 is the 11th annual technical clinic of its kind sponsored by Vickers. A number of papers on the state-of-the-art will be presented by leading authorities. Topics to be discussed at this year's session will include high temperature hydraulic systems, hot gas systems, refrigeration systems, and current operational experience with airline hydraulic systems. Attendance is by invitation.

Pneumatics to Operate Flight Control Surfaces

An Air Research and Development Command contract for design, development, and testing of a pneumatic system for operating flight control surfaces of supersonic aircraft and missiles has been awarded to General Dynamics Corp., The high temperature system will be nuclear radiation resistant. Such a system would replace present hydraulic systems for temperature above 1000 F. The half-million dollar, two-year contract will be performed for WADD by General Dynamics-San Diego.

Evaluation Test on Pneumatic Starters

During Air Force evaluation tests on cartridge-pneumatic starters built by the Garrett Corporation's AiResearch Manufacturing Division, the main engine starters of the F-100 aircraft operated over 5500 times with only one starter removal necessary. Over 2500 starts were by pilot-fired, solid propellant charge, and 3000 were standard pneumatic starts. AiResearch Phoenix also produces the dual-mode, cartridge-air turbine starters for the F-105 and B-52.

Gas Generating Power System Developed

Aircraft and Missile Consultants, Manhattan Beach, Calif., has developed a self-contained, gas generating power source small enough to be held, transported, and operated by hand. The system provides continuous, controlled, high-energy output. In one use, the system produces from 1 to 500 cu. ft. of cool gas at pressures from 3 to 3000 psi. As a reaction device, the system provides controlled thrust for orientation and stabilization, or it can be used as an emergency power source in manned capsules. Both the closed-system and aspirated-system versions use many small solid propellant gas generators which are easily replaced.

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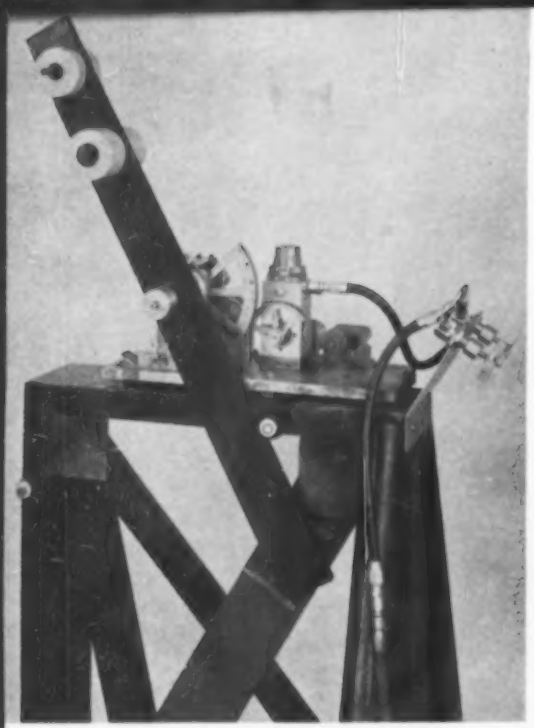

FIG. 1. LABORATORY TEST SET-UP for testing components in the hydraulic drive system. Weights attached to the arm simulate antenna load.

To compare a hydraulic servo system with an electrical control version, Lockheed Electronics engineers built both. Here is their evaluation.

FIG. 2. HYDRAULIC VERSION OF B-AXIS DRIVE puts out 130 watts at 1500 psi compared to 35 watts maximum for the electrical drive.

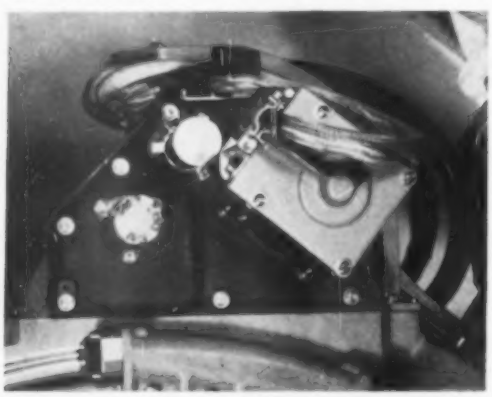

FIG. 3. ELECTRICAL VERSION OF B-AXIS DRIVE has a stall torque of 66 ft-lb compared to 78 ft-lb at 1500 psi for the hydraulic drive.

Hydraulic vs. electrical drive for airborne tracking antenna

• By **MYRON LEEDS, JOHN H. GASTON,**
Lockheed Electronics Co. Military Systems/Stavid Division, Plainfield, N. J.

ALPHONSE JACOBELLIS,
Greer Hydraulics, Inc., Westbury L. I. N. Y.
and BEAL P. MOORE,
Formerly at Lockheed Electronics. Now at Aerojet-General Corp., Downey, Calif.

HYDRAULIC servo system versus electrical servo-control system: we had to choose between them for driving a high-speed, airborne, radar tracking antenna. Selecting the optimum system for control drives of 1 hp or less usually requires rigorous design studies. However, the parameters of this application were so exacting that we decided to build the hardware for both systems to evaluate load, velocity, acceleration, accuracy, reliability, space, weight, and power source. The hydraulic servo system and drive components were jointly developed by Greer Hydraulics and Lockheed Electronics.

The electrically controlled version of this antenna has been through extensive laboratory and flight tests. The hydraulically controlled version is presently undergoing performance tests. We have enough test results to indicate superiority of the hydraulic system.

The hydraulic drive system with its compact size and weight is superior to the electrical drive system because it can handle high inertia loads. For applications of less than 1 hp, its low inertia com-

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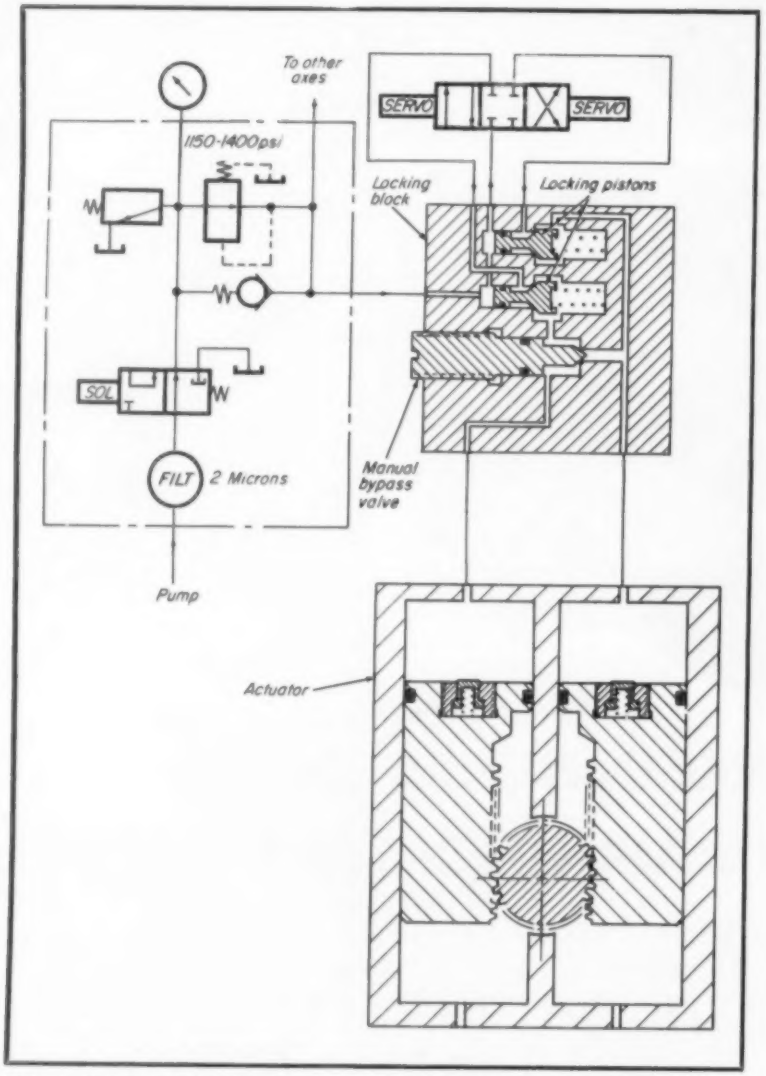

FIG. 4. HYDRAULIC CIRCUIT shows the rotary actuator and locking block. The locking pistons close at 400 psi and open at 600 psi.

HYDRAULIC vs ELECTRICAL

ponents and low impedance make it better than an electrical drive for its weight and size.

Test results indicate substantially higher torque and velocity constants with the hydraulic system. Also a much smaller scan angle was obtained. This was one of LEC's major performance objectives. Final checkout, adjustment, and tests of the control circuits were made on the completed assembly of the antenna in the laboratory. Thus, the final tests were made on the actual load. No servo data exists for the *A*-axis with the electrical system. For this system, the primary requirements were to have a scan mode of operation.

Hydraulic System Design

First we will review briefly the hydraulic system (see Figure 4), and then we will discuss development problems of several components.

The drive's hydraulic system receives MIL-H-5606A oil from a 1500- to 3000-psi supply. The oil passes through a 2-micron filter and then flows to an on-off, 3-way solenoid valve that is normally open. Then the oil feeds through a pressure reducing-relieving valve that supplies 0.8 gpm to the 3-axis servo system at 1150 to 1450 psi.

• **Check Valves Lock Actuator** —A check valve bypasses the reducing-relieving valve to the main hydraulic system return line. This

DESIGN SPECIFICATIONS

The antenna design required servo control of three axes. The power source was either 400-cycle, 3-phase, 115-vac electrical, or 1500- to 3000-psi hydraulic. Static loads are up to 3 g's in each axis. Miscellaneous requirements are locking, position limits, and snubbing on all drive axes. Temperature environment is −55 C to 95 C. Life is 150 hours without service, and 100,000,000 alternate reversals under load. Being an airborne antenna, weight and space must be as low as possible.

TABLE 1. ANTENNA ORIENTATION REQUIREMENTS

Axis	Motion -deg.	Maximum velocity -deg./sec	Maximum acceleration -deg./sec²	Inertia -slug-ft²	Accuracy -deg.
A	±60	126	2500 (turn around)	0.344	±¼
B	±35	50	115	0.77	±¼
C	±30	110	300	0.88	±¼

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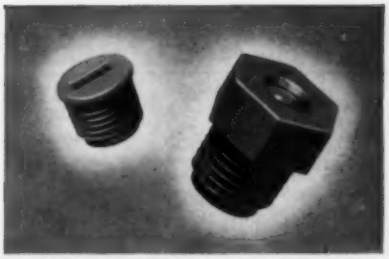

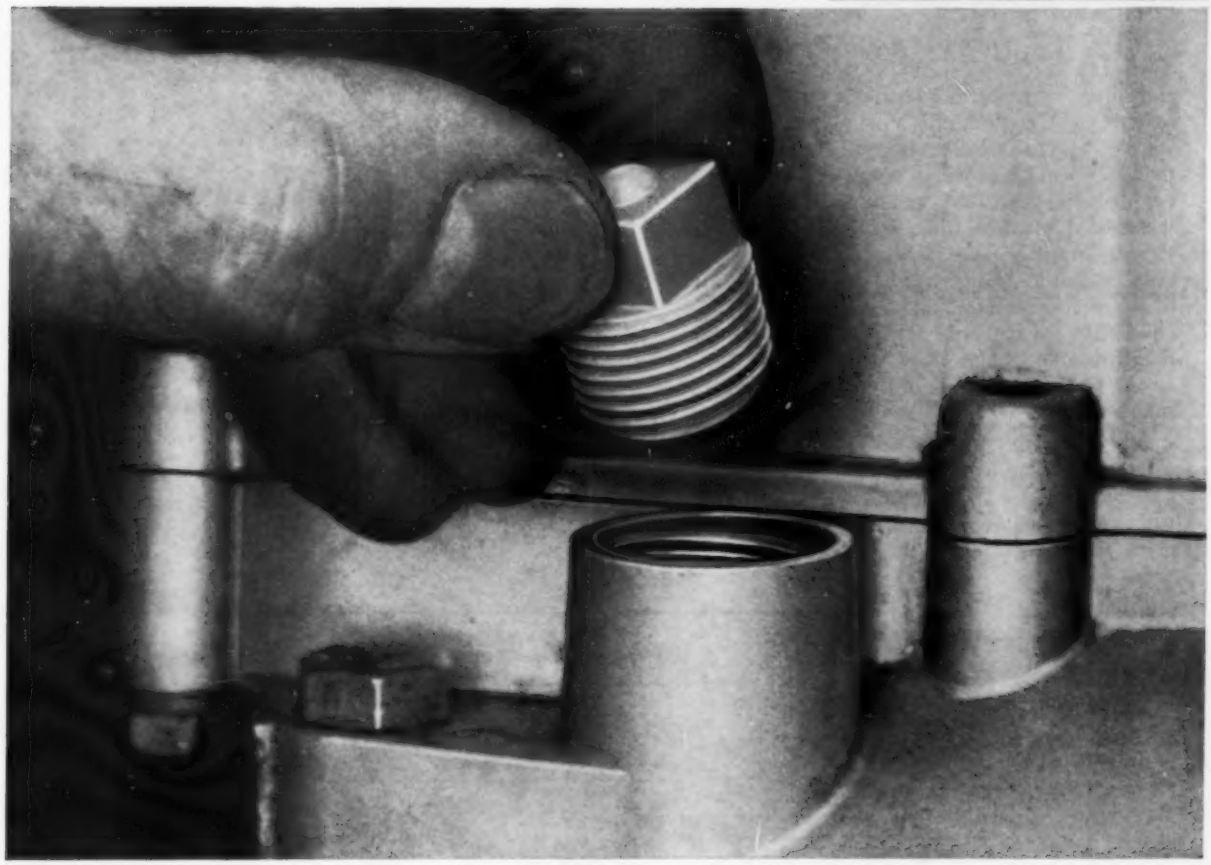

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check valve allows servo supply system pressure to drop to less than 400 psi. At 400 psi, the two pilot-operated check valves in each rotary actuator circuit close and hydraulically lock each actuator in position. With a rise in pressure over 600 psi, the pilot-operated check valves release all actuators, and oil through the locking block assembly pressurizes the servovalves. A bypass needle valve in the locking block assembly is used to manually release the pressure on the rotary actuators while servicing the antenna. The servovalves are pressure compensated. All three rotary actuators are rack-and-pinion, piston type for positive hydraulic locking. Each actuator's piston has a button-type snubber valve.

All hydraulic manifolds are 1500-psi, Teflon-lined, wire-braid covered hose that flex continually while the system is operating. The drive assembly for each axis weighs about 8 pounds.

MAJOR DEVELOPMENT PROBLEMS

HYDRAULIC SERVO	ELECTRICAL SERVO
Oil leaks	Poor response
Hunting	Additional gear meshes
Contamination	Maintaining clutch gap
Reliability of miniature check valves	Low power
Flex life of hoses	Maximum available rates were too low

● **Developing Components**—It takes more engineering to design a high response servo system, than just substituting a hydraulic drive for an electrical drive. The major problems that we solved by design and test engineering are briefly summarized. To design this system we analyzed the circuits to incorporate the required electrical constants, damping, and stability. Valve actuator transfer functions, including mechanical and electrical compliance, had to be calculated. The design goal was to make

Table 2. Comparison of Characteristics Electrical vs. Hydraulic Servo Drive System

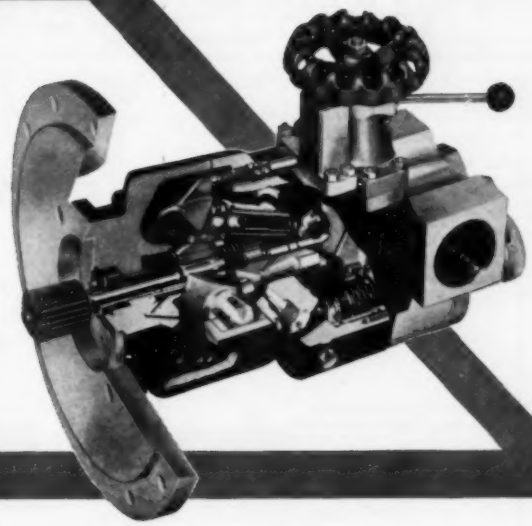
Item	Hydraulic Servo	Electrical Servo
Maximum power input-watts	15	128
Maximum power output-watts	At 1500 psi	
A-axis	130	68
B-axis	130	35
C-axis	487	35
Maximum stall torque-ft-lb	At 1500 psi	
A-axis	46	28
B-axis	78	66
C-axis	93	67
Weight of control circuitry-lb		
3-axis total	4.5	26
Weight of assemblies on antenna-lb		
3-axis total	29	27
Volume of controls-cu. in.		
3-axis total	110	750

Table 3. Comparison of Servo Performance

Item	Hydraulic Servo*	Electrical Servo
Velocity constant-sec		
A-axis	150	—
B-axis	312	260
C-axis	400	73
Torque constant-ft-lb/deg.		
A-axis	214	—
B-axis	1250	475
C-axis	572	129
Servo bandwidth (3 db)-cps		
A-axis	0.95	—
B-axis	1.34	1.54
C-axis	2.9	1.56
Minimum obtainable scan width-deg.		
A-axis	±5	±12
B-axis	—	—
C-axis	—	—

*For 1150-psi system pressure.

Nine piston, variable volume, pressure compensated type IA-38-9 pump, designed for use on Ground Support Equipment.



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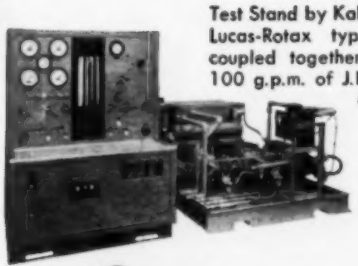

Test Stand by Kahn Company. Three Lucas-Rotax type IP-525 pumps coupled together provide flow of 100 g.p.m. of J.P.4 fuel for testing aircraft equipment.

Marine winches by Timberland-Ellicott are powered by Lucas-Rotax pumps and motors.

Two IA-38 pumps are incorporated in the portable Test Stand by Consolidated Diesel for use in checking out hydraulic system components on fighter aircraft at 5,000 p.s.i.

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system resonance 25 cps or higher. After this analysis, we made a breadboard test setup of each axis to duplicate each drive system. The breadboard system resonant frequency was about 10 cps. Why the difference between this figure and the design goal of 25 cps? Primarily because the higher figure assumed ideal conditions. However, the control system can be adjusted to meet basic performance requirements.

• **Motion Limiters**—All axes require scan or motion-limit controls to prevent the servo control and scanning programmer from running past the mechanical limits as the antenna oscillates. To prevent this there is an electrical limit switch circuit on the hydraulic drive. Also, a mechanical, spring snubber and a hydraulic actuator snubber protect the drive system from mechanical and hydraulic shock loads. The limit switches, hydraulic snubber, and spring snubbers are effective in the last 3° of motion on the three axes.

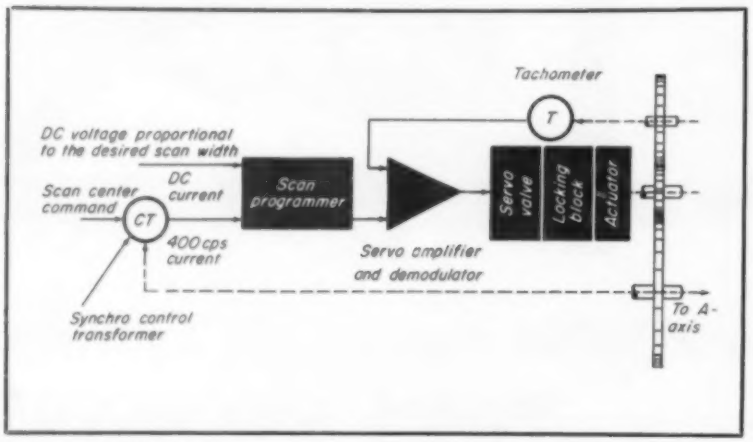


FIG. 5. ANTENNA had to scan back and forth at a uniform velocity in the A-axis. The scan width and center position are preset. The output voltage of the scan programmer is a 400-cps voltage of constant amplitude, which is either in-phase or 180 degrees out-of-phase with the 400-cps supply. This voltage is applied to the A-axis servo which is connected as a velocity servo. When the scan reaches a critical angle, determined by the input voltage to the A-scan programmer, the phase of the output voltage of the programmer is suddenly reversed. This reverses the axis motion. The critical angle is the scan width.

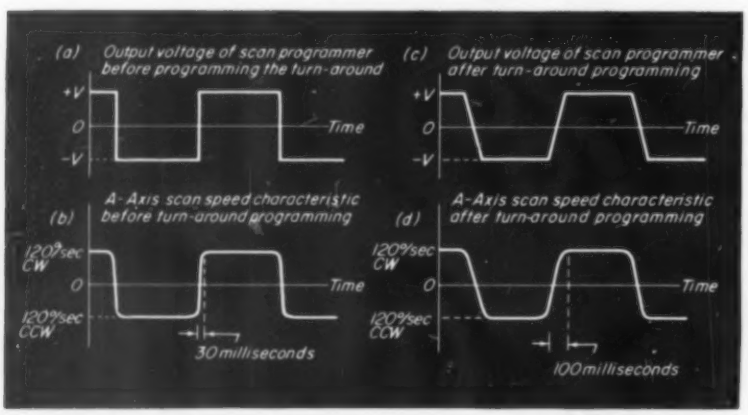


FIG. 6. SCANNING COMMAND SIGNALS AND A-AXIS RESPONSE. A-axis motion called for a programmed scan of 1 to 5 cps from ±60° to ±7.5°. A major problem was that turn-around forces exceeded the allowable design rates of the structural components. Gears failed because of this sudden motion reversal (about 8,000 deg/sec²) in 30 milliseconds. To solve this problem, stronger gears were designed and the turn-around program was regulated to reduce acceleration to 2400 deg/sec². Turn-around time was programmed to 100 milliseconds.

Before the turn-around was programmed, the A-axis was given a step order to reverse its rotation as quickly as possible consistent with the torque available from the actuator. The initial reversal command and A-axis response is shown in (a) and (b). Turn-around programming consisted of ordering the A-axis to reverse itself slower. This is indicated in (c). The response associated with the intentionally increased turn-around time is shown in (d).

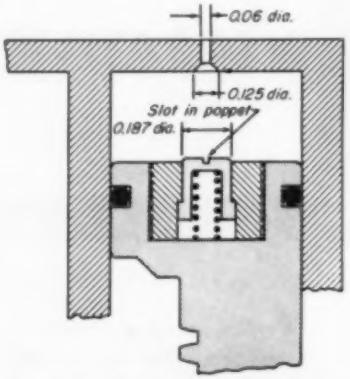


FIG. 7. HYDRAULIC SNUBBER in the rotary actuator. A tiny nylon poppet button with a knife blade slot across the top meters flow during the last three degrees of drive rotation.

• **Nylon-Poppet Snubber**—The design of the hydraulic actuator snubber was especially difficult. To prevent damaging the rack-and-drive pinion, snubbing was necessary. It was allowed in only a 2° to 4° angle of rotation with only 0.024 in. to 0.048 in. of motion of a 0.937-in. diameter hydraulic piston. Our first attempt, using a small ¼-in. piston in the center of the main piston, failed because of the critical tolerance control needed to restrict the flow of hydraulic fluid past the small piston orifice and its seals. The solution, reached after considerable development, is illustrated in Figure 7.

The snubber has a small, spring-loaded, nylon poppet valve button that bottoms on the oil port at the center of the actuator cylinder

HOKE Flow Sheet 7

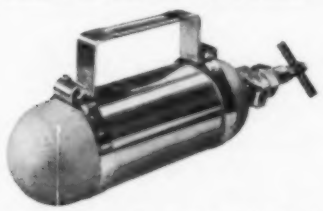
HOKE REPORTS ON FLUID CONTROL

PRESSURE BY THE POUND... no matter how thin you slice it!

Do You Have A Bomb In Your Lab?

In the process industry, sampling cylinders are occasionally referred to as bombs. In recent months, this misnomer has been, unhappily, pretty close to the truth. Some military surplus, low carbon steel, two-piece cylinders have found their way into industry and have been used beyond their rather limited capabilities. Unfortunately, several serious accidents have spotlighted this use as a very real safety problem.

Since sampling is such a serious business, we have perfected, for maximum safety, a seamless, one-piece cylinder. This unabashed declaration of excellence has sound



basis in fact – the entire cylinder is formed from a single piece of seamless type 304 stainless steel tube. To quell the qualms of process men, sample contamination is practically nonexistent, and the cylinder resists destruction from most corrosives.

As a further safety guarantee, all standard sampling cylinders are fabricated to meet ICC and other safety regulations. Standard cylinders are available at pressures to 1800 psi (10 ml. to 1 gallon), but higher pressure cylinders can be had on special order.

If you'd like additional information on Hoke cylinders, plus a detailed paper on the various methods of collecting samples from process lines, drop us a line. We'll also include details on special cylinder valves, outage tubes and other cylinder accessories.

One trouble with doing something better is that it's hard to stop. This time, we've come up with a new line of pressure regulators. We made them for the technically oriented who have developed high standards and for the penurious purchaser who wants something for (almost) nothing.

One, tagged as the 680 Series, is a highly stable single stage regulator with something for just about everyone. The core of this regulator is its control accuracy of 2% at flows to 2000 SCFH. Two models are available. One delivers 0 to 40 psi and the other 0 to 140 psi and both can handle inlet pressures up to 3000 psi. Use them on any gas compatible with 2024-T4 aluminum alloy, neoprene, polyurethane and Buna-N.

If what we've said sounds good so far, but still won't solve your problems, read on.

We've built a regulator specially for corrosive gases and atmospheres. Available in either all monel or all stainless steel construction, we call it the 640 Series. Spec sheets on this can be had by marking an "X" below.

If you "X" the next box, you'll get a package of useful information on a special regulator that will handle delivery pressures up to 4500 psi with

very high control accuracy. This is a 2 stage spring and dome loaded regulator and we claim that a 50% change in inlet pressure will not change the delivery pressure more than 2%. Operation is simplicity itself. For no particular reason, we call this the 920 Series.

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Circle 70 on Reader Service Card

head. Across the top of the button a small, knife blade slot, 0.005 in. wide by 0.005 in. deep, meters oil entering the cylinder port at the end of the actuator's stroke. The snubbing pressures are then distributed across the whole area of the actuator piston. This design has given effective snubbing repeatedly during operation of the hydraulic drives.

• Check Valves Lock Axis—The antenna axis must be locked when the drive system is not in use. Because of servovalve leakage in null position, it was not possible to lock the hydraulic actuator drives with a zero signal on the valve. The hydraulic locking circuit we developed is illustrated in Figure 4. Two pilot-operated check-valves between the servovalve and the rotary actuator lock the actuator. The two check valves normally close the actuator ports from the servovalve ports, but open when main system pressure reaches 600 psi. When system pressure drops to 400 psi, these valves close and lock the fluid in the actuator cylinders.

These check valves have metal-to-metal seats which are self-aligning and do not require precision machined guides to mate the poppets with the valve seats. Special assembly tooling and O-ring seals assure zero leakage for positive locking. A bypass needle valve enables maintenance personnel to move the antenna axis manually.

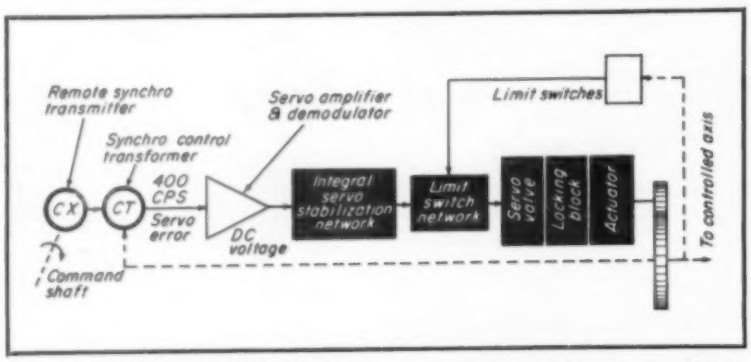

FIG. 8. HYDRAULIC SERVO SYSTEM uses a rotary actuator that is controlled by a hydraulic servovalve. When the output shaft position does not correspond to the position ordered by the synchro transmitter, an error voltage appears at the output of the synchro transformer. This voltage is amplified and demodulated in the amplifier. Demodulation is necessary to convert the amplified 400-cycle signal to d-c voltage required by the servovalve.

The d-c voltage first passes through an integral type, servo stabilizing network to help maximize the servo's velocity constant. Hydraulic fluid from the appropriate servovalve port causes the actuator to drive the synchro control transformer to a null. When this occurs, the load shaft position approaches the position ordered by the synchro transmitter.

The locking block has no significant affect during this mode of operation. It merely acts as a fluid path between the valve and actuator. The length of this path is made as short as possible to increase response. Tachometer stabilization is not necessary with the hydraulic servo. The required servo compensation network is simpler than that used for the electric servo drive.

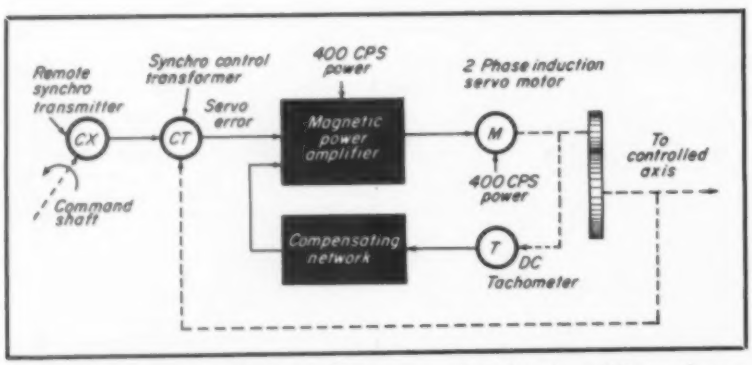

FIG. 9. ELECTRICAL SERVO SYSTEM uses synchro data transmitting and error sensing components. When the mechanical load shaft is not in the position ordered by the remote synchro transmitter, a 400-cycle error voltage appears at the output of the synchro control transformer. The amplitude of this voltage is proportional to the magnitude of the error. The phase of the 400-cycle voltage depends on the sense of the error.

The error voltage is both voltage and power amplified, and excites the control phase of the two-phase induction servomotor. This rotates the gear train in a direction that causes the servo error to tend towards zero, causing the output shaft to approach the position ordered by the transmitting synchro.

Tachometer feedback is necessary to stabilize the servo, with the gain of the amplifier adjusted to a sufficiently high value.

• Pressure Surges Measured—Surge tests indicated that with 1150-psi system pressure, 300- to 500-psi surges occur at the inlet to the servovalves. These surges had to be absorbed by ¼-inch, wire-braid Teflon hoses whose life ratings under flexure and pulse were limited to 1700 psi at a normal operating pressure of 1500 psi. The highest surge pressures occured during scanning motion of the A-axis at its instant of reversal. This required control over turn-around rates, and hydraulic and mechanical snubbing at the mechanical limits. When reversal occurs within the scan limits, surge pressures are limited by the programmed, turn-around technique. (See Figure 6.) Surge pressures within the actuator cylinders are much greater, about 3000 psi.

These pressure pulses must be measured with equipment having a frequency response capable of recording the full character of the pulses. Low response equipment may produce the false impression that the pulses are of a much lower pressure than they actually are.

To meet pressure requirements, the servovalves were designed for

3000-psi with a proof pressure of 4500 psi. Relief valves originally used in the actuator circuit were a source of trouble and were eliminated by making the locking block actuator assembly heavier. All seal leakage was eliminated.

• **Tests Reveal Weak Points**—An extensive test program was carried out to achieve maximum reliability. The importance of such a program cannot be overestimated. We tested moving parts and those subject to contamination under conditions that duplicated actual operation as closely as possible. For example, hoses were flexed far in excess of any tests run by the manufacturers. Our target was 2 million flexing cycles. The first sample failed after only 60,000 cycles. However, the tests pointed up the weak spots, and eventually we reached the desired goal.

• **Perfect Braid Necessary**—We found that the method of clamping hose was most important. Short sections of Teflon tubing were slipped over the hose to gradually reduce flexing in the clamp area. We found that hose with a perfect braid pattern far outlasted hose which had errors or overlaps. This was where most failures started.

• **Other Applications**—Future applications for this type of servo drive system are drives that must have accurate position control at high acceleration rates in the ½-hp to 10-hp range, with rate limits to 100 cps depending on the characteristics of the load. Typical applications are tracking radar antennas, missile guidance systems, shipboard stable platforms, airborne stable platforms, and aircraft flight control surface drives. ▼▼▼

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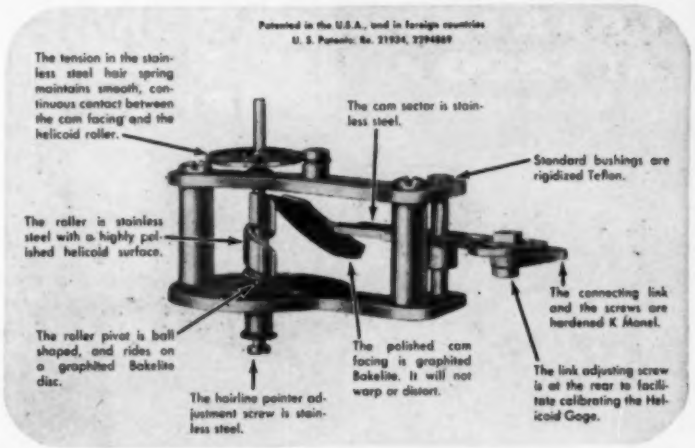
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U. S. Patents: Re. 21934, 2794889
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AEROSPACE COMPONENT DATA

Recording Servovalve Test Stand

Features: Test stand automatically records combinations of flow, piston force, pressure, and displacement in X-Y form. Plotted continuously with out recycling.

Specifications: System capabilities are: Flow, 5cc/min to 1000 gpm. Force, 0.1 gm to 5 tons. Displacement 0.0001 in. increments to any amplitude. Pressures to 5000 psi. Accuracy of the flow system is ±½% of the instantaneous reading.

Designation: Model 2784.—*Auto-Control Laboratories, Inc., Los Angeles.*

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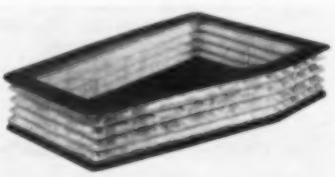
Missile Launcher Boots

Features: Protects delicate control parts on launching apparatus. Aluminized asbestos combined with various flame resistant materials used. Four sections open to 6", close to 1". Resists temperatures over 2000 F. —*A & A Mfg. Co., Inc., Milwaukee.*



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Flow Control Valve

Features: Maintains flow setting within 15% variation, with constant inlet pressure and outlet pressure varying from 500 to 1500 psi. Useable with MIL-H-19457 fluid or any other fluid. Pressure drop at 120 F and rated flow is 50 psi maximum. Set on subplate. Temperature range is 30 F to 160 F.

Designation: 9901, adjustable from 5 to 25 gpm. 9902, adjustable from 20 to 50 gpm.—*Arkwin Industries, Inc., Westbury, N. Y.*

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Features: Withstands temperatures from −450 F to 1200 F and peak pressures to 40,000 psi. It is ideally suited to provide elastic deflection and high sealing force. In a typical static sealing application, the seal had zero leakage from room temperature to 1000 F with dry nitrogen at 1000 psi.

Designation: Bar-X-Seal.—*Wiggins Connectors, Los Angeles.*

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Flame Arrester For Pneumatic Systems

Features: Flame arrester for airborne pneumatic systems prevents oil-air explosions in such places as reservoirs or moisture separators. It prevents flame fronts or pressure surges due to flame fronts from contacting any system volume. For use on the outlet stage of any high pressure air compressor or at the intake of any moisture separator. Arrester is normally open and allows up to 8 scfm air flow. If a surge occurs, the poppet valve in the device automatically closes. Can be used to modify any existing pneumatic system.

Continued on page 118

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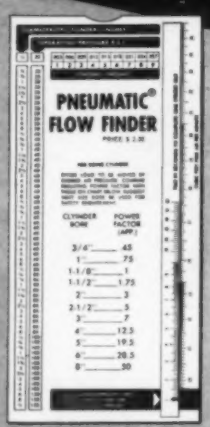

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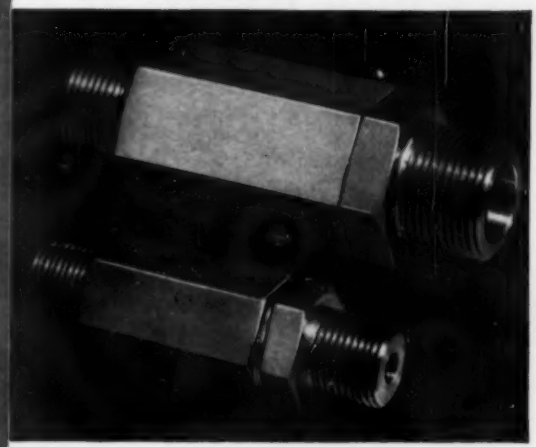

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Designation: Part No. 47260-001-01.—*The Cornelius Company., Aero Division, Minneapolis.*

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Specifications: This pilot-operated unit is for pressures to 500 psi, or 3500 psi with minor modifications. Valve will actuate fully in 15 millisec. Leakage is well below 1cc/hr. —*James, Pond & Clark, Inc., Pasadena, Calif.*

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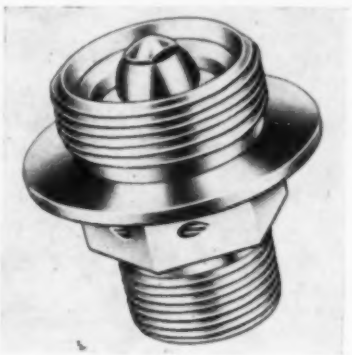
High Temperature Magnetic Chip Detector

Features: Operates satisfactorily at temperatures to 600 F. Does not require elastic seals. For aircraft



applications. Ferrous particles bridge an electrically insulated gap in the detector to light a warning light.—*Lisle Corporation, Clarinda, Iowa.*

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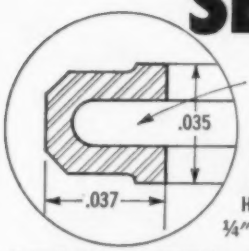

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Bubble Point Test Stand

Features: Portable, suit case type unit detects and measures openings from 13 to 120 microns in any type of filter element. Also determines valve seating and measures small orifices. Filter elements with open seams or poorly bonded end caps may also be detected. Simple to use. Send for Bulletin A-11.

Specifications: Uses shop air at 6 to 250 psi. No electrical input needed. Size, 23 x 12 x 8 in. Weight, 15 lb. Largest element accommodated, 4 x 18 in. long for flat elements, or 4 in. in diameter for round. Tests for requirements of filter specifications MIL-F-5504B, MIL-F-8815 (ASG), and MIL-F-25682 (USAF).

Designation: 01414.—*Aircraft Porous Media, Inc., Subsidiary of Pall Corp., Glen Cove, N. Y.*

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Exclusive features, like Atchley's Jet-Pipe servovalve (above) are one good reason. The Jet-Pipe can pass fluids with contaminants as large as 300 microns and still operate perfectly.

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If your concern is a system involving electronic, hydraulic, or pneumatic servo controls, let Atchley wrap it up for you.

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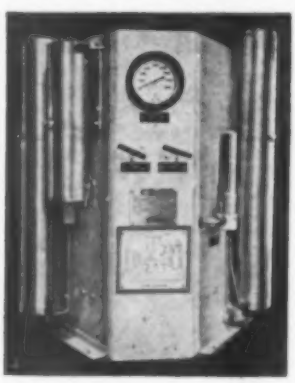

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AEROSPACE NEWS

from the fluid power field

Jet engine starter uses plant air

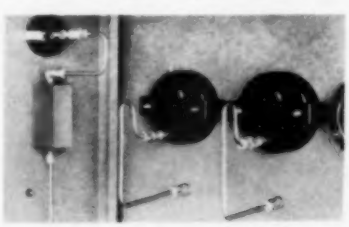
Pressurized air from North American Aviation's plant-air system starts jet engines at North American Aviation's Columbus, Ohio, Division. The method is faster, safer, more efficient, much less expensive, and easier to operate and maintain than mobile compressor units or mobile compressed air storage tanks.

Jet engines are started by forcing compressed air into the engine to begin turning the blades of the turbine. Once the turbine rotates fast enough to start the engine, fuel is injected and ignited. After the engine reaches a predetermined speed, the air is automatically cut off. The entire process takes less than 30 seconds.

Exact control of pressure was a problem. A pressure controller, made by U. S. Gauge Division of American Machine and Metals, limits air pressure to 61 psig. Pressure greater than 61 psi could rupture the engine manifold.

Snubber protects gages on Hawk test station

To eliminate pressure gage failure due to hydraulic or pneumatic shock and to smooth out pressure impulses and fluctuation, Raytheon Co. installed snubbers to protect



the gages on their test station for U. S. Army Hawk missiles. The heart of the snubber which is made by Chemiquip Co. is a ¾-in. diameter x 0.1-in. thick disc of corrosion-resistant, porous metal.

When a snubber is placed in the line immediately upstream of the pressure sensitive instrument,

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S.A.E. straight thread tube fittings

Form the standard, internal o-ring boss and port contour for the new straight thread tube fittings recently introduced by major fitting manufacturers to replace taper pipe ports.

- forms complete contour in one pass
- choice of plain or reamer pilot
- high speed steel, form relieved for easy reconditioning
- also cuts MS 16142
- also available as standards in carbide

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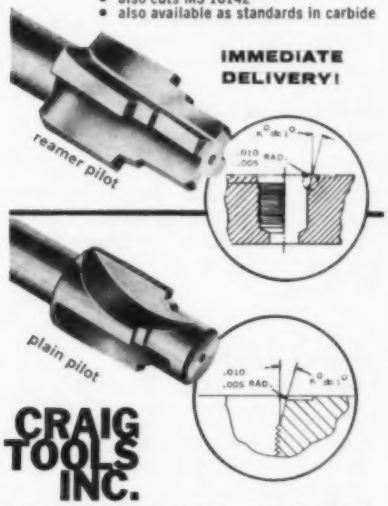

CRAIG TOOLS INC.

133 Lomita Street, El Segundo, California

its response is proportional to the pressure drop across the snubber element. The instrument's response is moderately rapid, but free of transient line surges. The snubber is calibrated to give an equilibrium reading upscale or downscale in about 2 to 3 sec.

Hydraulic power drives radar antenna

The hydraulic power supply for the U. S. Navy Mark 73 Director, which drives the radar antenna controlling Tartar missile firing, was designed and manufactured by Eastern Industries, Inc., Hamden, Conn., under contract to General Electric's Ordnance Dept. This shipboard package consists of a 400-cycle motor driven pump and an emergency hand-operated pump, manifolded to a housing containing a reservoir, relief and check valves, filter, sight glass, and pressure switch.

The hydraulic power supply, which has special precautions against oil foaming, is driven by a small lightweight, gear pump.

Buckley to direct marketing

James P. Buckley has been appointed to the newly created post

Continued on next page

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the big seal of

RELIABILITY

TERRIER TARTAR SERGEANT MERCURY ATLAS POLARIS

SEATON-WILSON
MANUFACTURING COMPANY
911 NORTH VICTORY BLVD.
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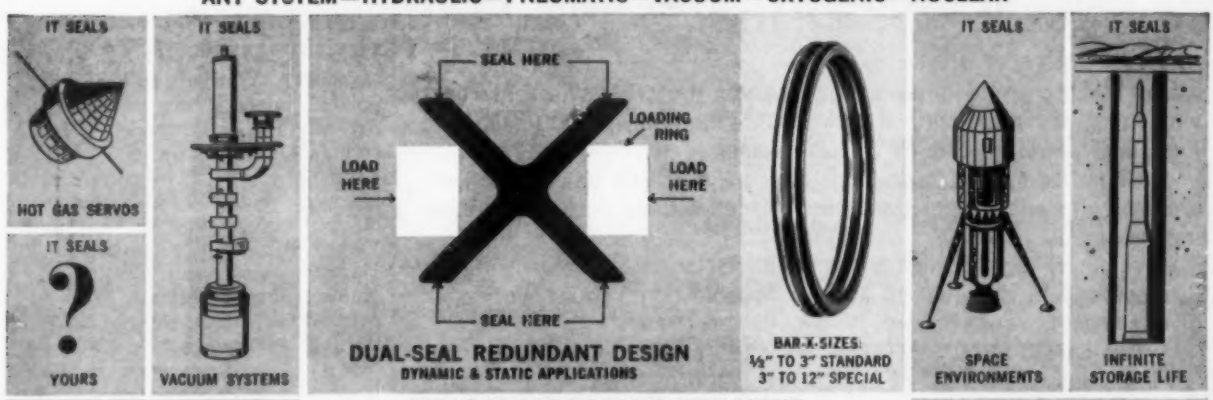
ANY SYSTEM—HYDRAULIC—PNEUMATIC—VACUUM—CRYOGENIC—NUCLEAR



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No Leaks at 6000 psi...Even Hand Tight

CPV O-SEAL SYSTEM valve and union connections thrive on pressure —and the higher the pressure, the tighter the seal. With only light wrenching, any connection is leak-proof to well above 6000 psi. Even line surge or vibration can't cause leakage.

Unlimited system flexibility is at your finger tips. Valves or unions are easily installed, repositioned or replaced without cutting or springing the line.

Valve leakage at high pressure is no longer a problem, either. CPV soft-seated valve design assures "bubble-tight" shut off of water, oil or any gas . . . even helium.

Two CPV O-SEAL SYSTEMS—for 1500 or 6000 psi service—perform faultlessly from -20° to +275°F. **GLOBE, CHECK, or RELIEF VALVES** plus a full line of fittings including tees and elbows are available . . . in sizes from ⅛-inch to 2-inches.

Details and specifications are waiting for you in Catalog 60B. Let us know where to send it.

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COMBINATION PUMP VALVE CO. / 846 Preston Street, Philadelphia 4, Pa.

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AEROSPACE NEWS

from the fluid power field

of director of marketing and planning for Bendix-Pacific division, The Bendix Corporation. A veteran of 20 years of service with Bendix, Buckley most recently was director of sales and service for the Eclipse-Pioneer division, Teterboro, N. J.

Kidde names district manager in Atlanta

J. William Gray has been appointed southeast district sales manager for Kidde Aero-Space Div., Walter Kidde & Company, Inc., Belleville, N. J. His office is in Atlanta.

Weatherhead has new Los Angeles sales manager

Richard D. Hus is the new district sales manager for the aircraft and missiles sales staff of The Weatherhead Co., Cleveland. Hus will make his headquarters at Weatherhead's Glendale, California, plant and will provide sales and application engineering service in the Los Angeles area.

Wotring is Vickers service manager

James A. Wotring has been appointed general service manager of Aero Hydraulics Div., Vickers Incorporated, Division of Sperry Rand Corp., Detroit. For the past two years Wotring was in charge of Systems Engineering at the Vickers Torrance, California plant, He was responsible for such programs as the Minuteman and Skybolt APU's and the AN/USD-5 starting and generator drive system.

Eastern Industries pump used on executive transport plane

All current production models of the Aero Commander will use an Eastern Industries gear pump for landing gear and flap actuation. This executive transport will use a model which is part of a family of gear pumps delivering from 1.3 to 3.6 gpm with pressures to 1500 psi. ▼▼▼

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measurement and control

OF PRESSURE AND DIFFERENTIAL PRESSURE

DELTADYNE® SWITCHES
Pat. No. 2,942,572
Adjustable for signalling pressure and differential pressure from 0.25" wc to 200 psi (or psid) in systems to 5000 psi and −65° to +275°F; leak-proof. Units sound alarm, light bulb, turn motor on or off, operate valves—remotely or in place. **$40 to $75**

DELTADYNE INDICATORS
Adjustable and non-adjustable. Actuation 0.01 to 100 psi (or psid). For same pressure/temperature as switches. Red button pops to give visual indication of overpressure. **$22 to $85**

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For system pressures to 3000 psi; indication from 0 to 60 psi differential; leak-proof—no moving seals; high-visibility scale. **$92**

Extended pressure and temperature ranges available in all instruments.

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NEW ACCURACY!

OFF-THE-SHELF OR CUSTOM-ENGINEERED FOR

- Hydraulic/pneumatic systems (airborne, ground support, industrial)
- Process industries (chemical, petroleum, fuels)
- Equipment manufacturers (fluid handling)

Read or control tank levels, and pressure drops across filters, heat exchange orifices for flow metering, gas adsorbers and many other types of equipment. Learn more about the cost and service advantages of these units.

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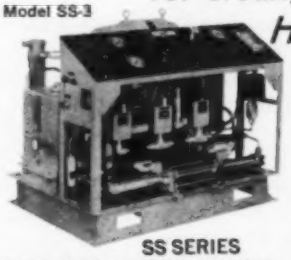
GAS BOOSTER COMPRESSORS

for clean, Uncontaminated HIGH PRESSURE GAS Requirements

Model SS-3



SS SERIES
HYDRAULIC DRIVEN MODELS

Boost bottled gas to pressures as high as 15,000 psig without contaminating the gas. Single or two stage models for compression ratios as high as 16:1. For use with nitrogen, helium, argon, dry air or any other inert gas. Available in 7½, 10 and 15 H.P. sizes for average flow rates up to 20 scfm.

Send for our new 24 page Catalog (No. M-1).

AG SERIES
AIR DRIVEN MODELS:

Boost bottled gas up to 10,000 psig using 80 to 150 psig plant air supply. Provides same uncontaminated gas as SS models. Available in single stage or two stage types for up to 16:1 compression ratio with flow rates as high as 14 scfm. Cooling water not required as driving air exhaust is used for gas intercooling and aftercooling.

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we knock the "L" out of PROBLEMS

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Whatever your problem, if the need is diaphragms, actuators, accumulators, metering or pressure sensing devices, you can look with confidence to Aero Gasket for the solution. Aero Gasket also designs and manufactures seals, gaskets, and precision parts of metal and/or molded materials. **SEND PRINTS AND DETAILS FOR PROMPT QUOTATIONS.**

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☐ Seals and gaskets ☐ Precision molded parts
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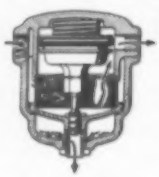
WILKERSON
eliminates human failure

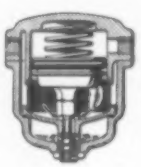
only . . .
$8.90 for ¼"N.P.T.

The WILK-O-MATIC will cycle over 3 million times without failure

Leading OEM manufacturers and maintenance engineers use the WILK-O-MATIC to extend life of machines and tools by removing moisture and contaminants from compressed air, automatically.



WHEN AIR IS USED,
piston automatically opens sump drain valve. No moisture accumulates, which eliminates danger of water re-entering air stream.



WHEN AIR FLOW STOPS,
moisture collected in upper chamber drops to sump—unit is then ready to drain itself.

★ No plastic bowl nor drain line needed
★ Requires less space than manual types
★ 10-250 PSI with up to 55 CFM capacity
★ ¼" to ½" P.T. sizes
★ Filters out all water and dirt as small as 5 microns

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Dedicated to keeping the NEW in pNEUmatics

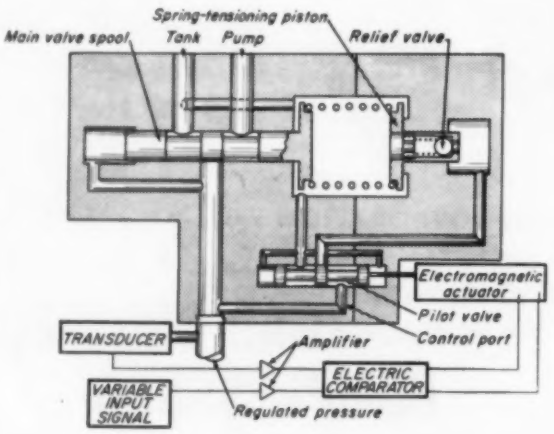
Circle **156** on Reader Service Card

FLUID POWER PATENTS

Servo Controlled Pressure Regulator

Conventional pressure regulators provide a constant outlet pressure with varying inlet pressure. This regulator automatically varies the outlet pressure in proportion to a variable electrical input signal. It also has an integral relief valve which limits its maximum output pressure.

The drawing shows the valve in its stable position with no fluid flowing and no pressure change being demanded.



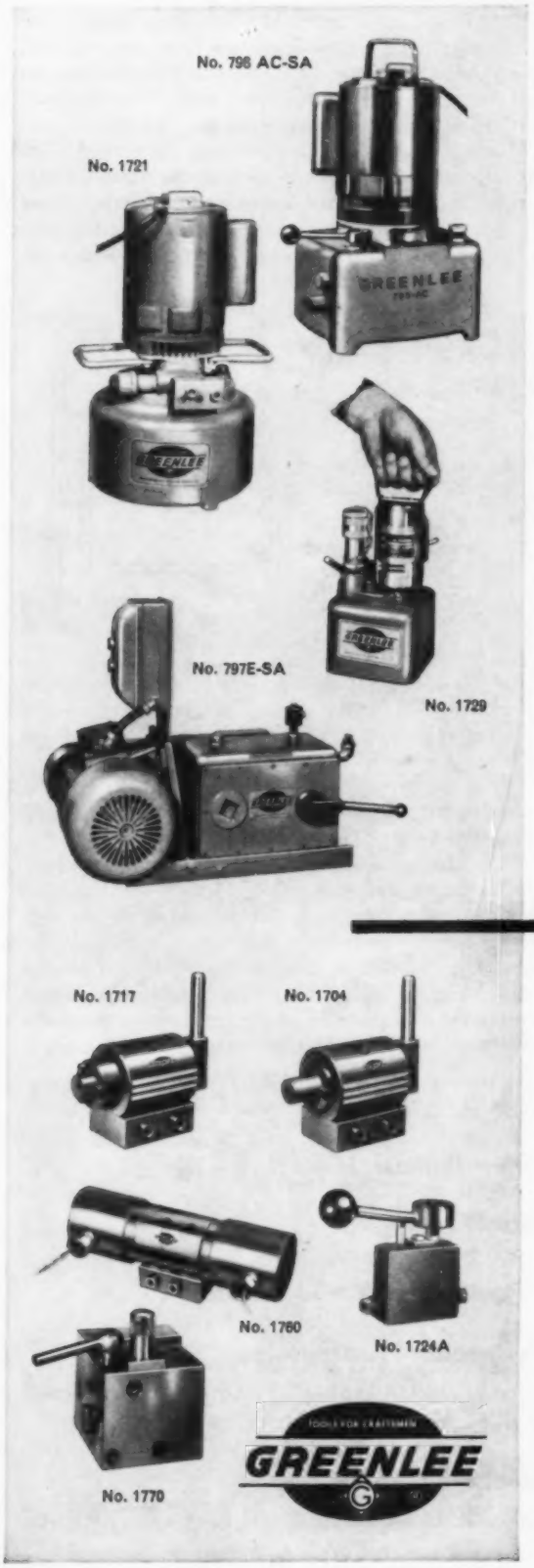
When pressure at the regulated port drops, pressure also decreases at the left of the main valve spool. Pressure on the right of the spring-tensioning piston moves the main spool left, connecting the pump port with the regulated port. When the regulated pressure reaches its setting, the spool centers and leakage from the pump port to the regulated port equals leakage from the regulated port to the tank port. This leakage maintains a constant pressure in the regulated port.

The comparator continuously compares the input signal with the pressure-sensed signal from the pressure transducer. If the difference in the two signals indicates that a higher or lower regulated pressure is required, the comparator transmits a signal to the pilot valve electromagnetic actuator. This signal moves the pilot valve spool varying flow to the right of the spring-tensioning piston. The piston moves to increase or decrease spring tension, which raises or lowers regulated pressure.

If regulated pressure increases to a set limit, the relief valve opens preventing any further increase.

U. S. Patent No. 2,984,251 by Charles E. Quimby, Grand Rapids, Mich., assigned to Lear, Inc.

See GREENLEE first



...for HIGH-PRESSURE HYDRAULIC POWER PUMPS... UP TO 10,000 PSI

- 10 series, 35 models
- Pressures to 10,000 psi continuous
- Delivery volume to 213 cu in. per minute
- Fast-approach feature
- Electric and gasoline powered
- All models fully portable

No. 798 series two-speed pumps—with high-volume, low-pressure drive . . . automatic change-over to low-volume, high-pressure. Three-way control valve. 6000 psi continuous pressure, 10,000 psi intermittent . . . delivers 28 cu in. per min at 10,000 psi. 4 models . . . electric or gasoline powered. *Note: Greenlee No. 798 series pumps also are available with a four-way valve that provides two-direction action for hydraulic ram advance and return.*

No. 1721 heavy-duty pump—for a wide variety of hydraulic applications—in the field, plant, or laboratory. Delivers 30 cu in. per min at 10,000 psi continuous pressure. Choice of three-way, four-way, or four-way spool-type control valves. Three power sources—¾ or 1½ hp, 115-230 volt a-c electric motor; 2 hp gasoline engine.

New No. 1729 extra-lightweight (14 lb) pump—ideal compact power source for rams, jacks, pullers, and similar tools with high-pressure, low-volume requirements. Up to 10,000 psi pressure.

No. 797 series high-capacity pumps—deliver up to 213 cu in. per min at 10,000 psi continuous pressure. Pump, reservoir, control valve contained in one housing. 8 models, available on skids or rubber-tired undercarriage. **No. 797E-SA** (shown) available with 2 or 3 hp, 220-440 volt motor. 2 hp model delivers 106 cu in. per min, 213 cu in. per min with 3 hp. Built-in two-way control valve, four-way spool-type valve optional (797E-TA model). **No. 797G-SA** is powered by 4½ hp, four-cycle air-cooled engine. Delivers 106 cu in. oil per min at 10,000 psi. Built-in, two-way control valve . . . four-way control valve optional (No. 797G-TA model).

...and CONTROL VALVES

- 6 series, 10 models
- For circuits developing up to 10,000 psi
- Compact, dependable

No. 1704 spool-type four-way control valve—for panel or subplate mounting. Three positions—*advance, neutral, and return.* Spring-centered control handle.

No. 1717—same as No. 1704 but features detents to retain the spool in any of the three positions. Both valves balanced for easy operation.

No. 1724A free-flow metering valve—for maintaining ram pressure in system with power off or for controlling ram return speed.

No. 1760 solenoid-operated valve—essentially the same as No. 1704 but is equipped with solenoids for remote electrical control. Usually furnished (as shown) with a No. 1713 subplate which provides 10,000 psi at both outlet ports.

No. 1770 flow control valve (pressure compensated)—with No. 1771 subplate for panel mounting—micrometer-type setting knob adjusts flow from 5 cu in. to 800 cu in. per min.

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Periflex • Inc.

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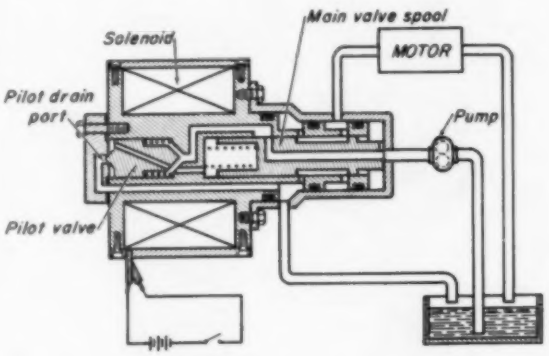
Proximity Solenoid Valve

The pilot on this solenoid valve is completely enclosed within the valve. It differs from conventional pilot-operated solenoid valves in that the pilot has no stem extending through the valve body. This construction eliminates all external dynamic packing.

When the solenoid is de-energized, the spring holds the pilot valve plunger left, closing the drain orifice. Supply fluid enters the valve on the right, flows through the hollow main spool, and through the port in the pilot plunger. With equal pressure at both ends



of the pilot valve plunger, the spring holds the plunger closed. An additional closing force is created by the unbalanced pressure on the right of the plunger over an area equal to the area of the pilot valve seat.

The main valve spool also has system pressure at both ends. A spring holds the spool right, stopping pump flow from pump to motor.

When the solenoid is energized, the pilot plunger (which forms the solenoid armature) moves right. This movement opens the drain orifice at the left of the plunger and closes the supply orifice at the right. The chamber at the left end of the main valve spool drains to tank through the port in the poppet plunger. System pressure at the right moves the main valve spool left connecting the pump and motor port.

U. S. Patent No. 2,977,984 by Phillip E. Barnes, assigned to United Aircraft Corp., East Hartford, Conn.

Other Patents Issued

Relief Valve

No. 2,989,072 by Oscar H. Banker, assigned to Fawick Corp., Cleveland, Ohio.

Hydraulic Transmission

No. 2,988,007 by B. F. Quintilian, assigned to Gerotor May Corp

Unloading valve

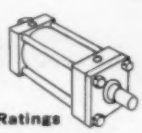
No. 2,989,066 by Francis F. Norlin, assigned to Borg-Warner Corp., Chicago. ▼▼▼

THIS...IS WHAT YOU BUY!

POWER — clean, dry, drip-free power at the business end of a Hannifin piston rod is the result of Hannifin extra quality, and at no extra cost. Bores are honed to 15 RMS or finer . . . piston rods are case hardened, plated and polished to 10 RMS or better. Cartridge gland, removable without dismantling cylinder, has exclusive Hannifin-developed "Lipseal®-Wiperseal" combination for a truly drip-free rod.

Modern straight thread leak-proof ports for easily positioned fittings are available at no extra cost on hydraulic cylinders.

HYDRAULIC CYLINDERS



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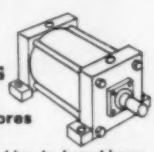
2000 psi (3000 psi non shock), the famous heavy duty Hannifin Series "H" in 1½" to 12" bore.
1000 psi, Series "L", 1" to 8" bore, Hannifin quality in a lighter cylinder. Full compliance JIC Hydraulic Specs.

AIR CYLINDERS



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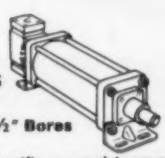
Series "A"—steel heads, honed brass body for corrosion resistance. Hardened and hard chrome plated piston rod. For all heavy duty air service. Easily modified for water service. Full compliance JIC Pneumatic Specs.

AIR MOTORS



1¾" to 4½" Bores

New from Hannifin, a complete power package combining cylinder and solenoid valve. Only one air line connection. Four mounting styles. Interchangeable mounting dimensions for most applications.

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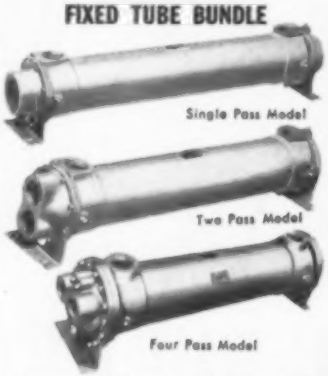

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Two Pass Model

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Type "F" heat exchangers are made in copper base alloy, steel or stainless steel construction. Over 400 standard models. Catalog 1261.

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YOUNG RADIATOR COMPANY
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Plants at Racine, Wis. and Mattoon, Ill.

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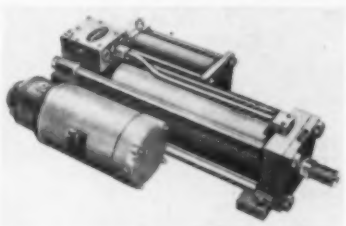
NEW PRODUCTS

Continued from page 52

POWER UNIT/CYLINDER PACKAGE

Completely closed, pre-filled system is especially suited for heavy duty, single unit, industrial applications. Connects to electric power source through a reversing switch. Will operate in any position.

Specifications: Only three electrical connections. ⅓ to 10 hp motors. Up to 2000-psi operating pressure.

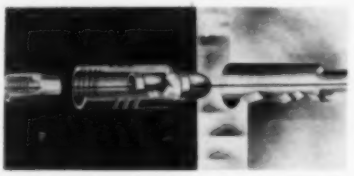


Designation: POWR-PAK.—*The Sheffer Corp., Cincinnati.*

Circle **309** on Reader Service Card

FIXED RESTRICTOR WITH FILTERS

Restrictor with calibrated orifice can be inserted in a hole and locked and sealed quickly. Two, 100-mesh, matched filters allow flow in either direction. To install, slide restrictor into the reamed hole until it seats at the shoulder. Press pin into the restrictor. Pin acts as an expander



to lock and seal the restrictor. Both pieces are reusable, and may be simply removed with an extraction tool. Customer specifies either the hole size (0.050" max.) or the flow and pressure drop. Catalog available.

Designation: Jets.—*Lee Company, Westbrook, Conn.*

Circle **310** on Reader Service Card

DIAL OPERATED VALVE

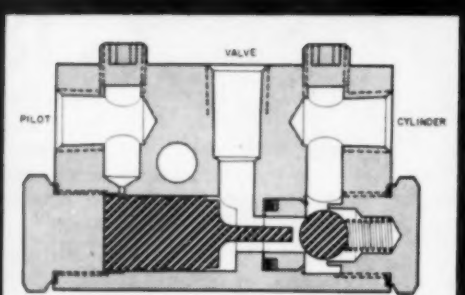
The Dial-A-Flow, priority type, flow divider valve has dial-actuated

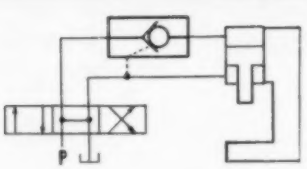
Continued on page 130

Positively Lock Circuits Or Cylinders...Until Released

PILOT CHECK VALVES

- For clamping or holding circuits
- Allows use of inexpensive control valves
- Long trouble-free service





- Standard Ports—¼", ⅜" and ½" pipe (NPTF)
- For oil to 3000 psi

Write for detailed information

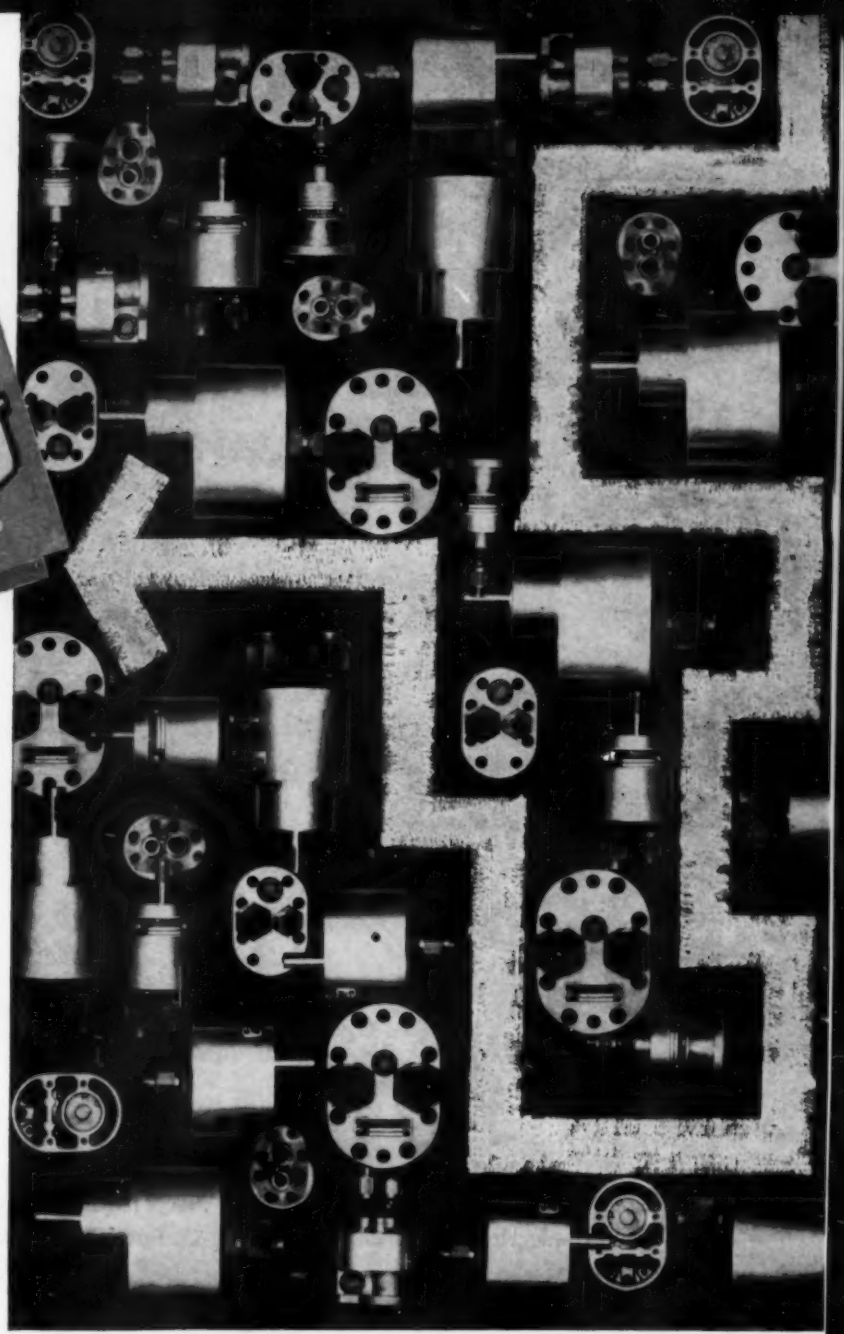
Fluid Controls, inc.

Manufacturers of Hydraulic Valves and Devices
Relief Valves • Check Valves • Restrictor Valves
Needle Valves • Pilot Check Valves • Special Valves
Pressure Compensated Flow Regulators

P. O. Box 186 • Mentor, Ohio • HI 5-3426

Circle **44** on Reader Service Card

Circle 42 →



your guide to *the gear pump* for your application

This new catalog is an invaluable directory to no less than 129 pump-and-electric-motor-combinations — any and all available off-the-shelf!

Searching for gear pumps with top volumetric efficiencies? Do your performance requirements fall into one of these three major groups?

- Eastern 1200 series — up to 1.6 gpm — pressures to 800 psi
- Eastern 100 series — up to 5 gpm — pressures up to 1500 psi
- Eastern 700 series — up to 9.8 gpm — pressures up to 1500 psi

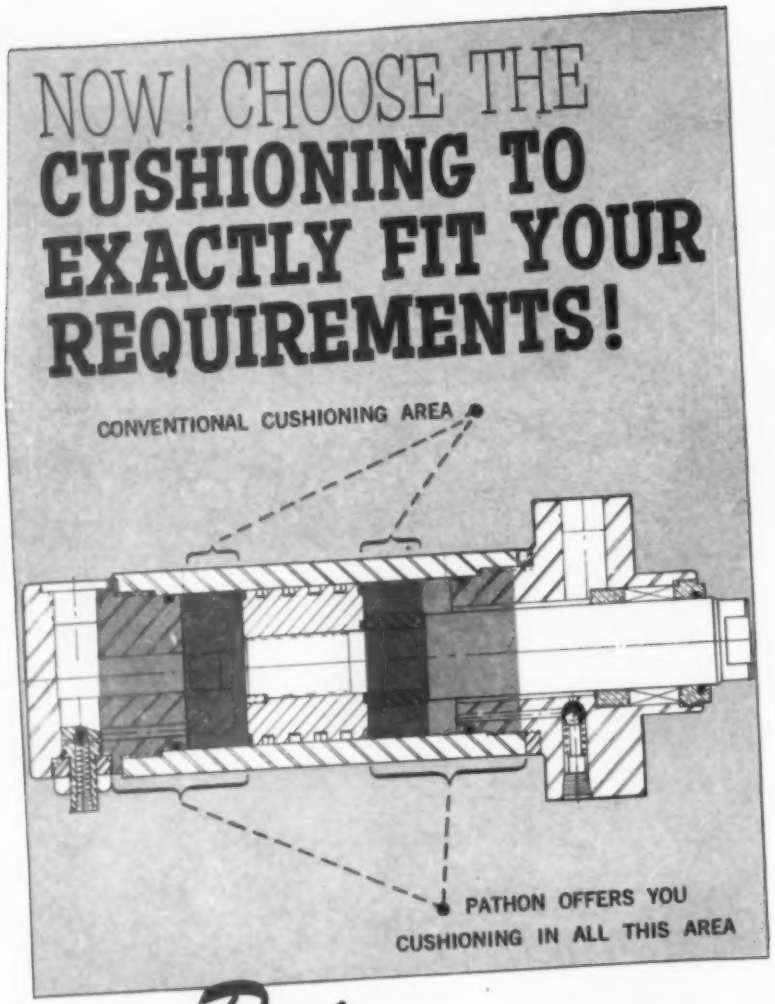
If one or more of these performance ranges measures up to what you need, save hours of searching your way through the gear pump maze — send for catalog 810 now!

Other Eastern products:

- **hydraulic motors**
- **positive displacement pumps**
- **centrifugal pumps**
- **aircraft pumps**

EASTERN INDUSTRIES, INCORPORATED
Hamden, Connecticut

NOW! CHOOSE THE
CUSHIONING TO EXACTLY FIT YOUR REQUIREMENTS!



Another **Pathon** *First !*

High speed cylinder operations frequently require more refined deceleration techniques than ordinary cylinder cushions.

Now, Pathon cylinders are available with adjustable or non-adjustable cushions that are three to four times longer than ordinary cushions to provide the effective control required.

This extra length does not increase standard catalog dimensions and you can customs-specify any length or configuration up to the maximum.

Write for "LET'S TALK CUSHIONS" for details.

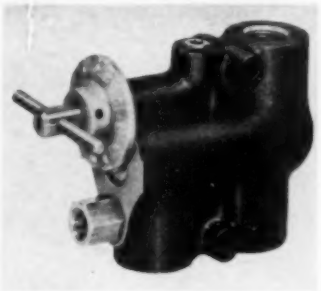
Pathon MANUFACTURING COMPANY
3823 Pacific Avenue, Cincinnati 12, Ohio

FLUID OPERATED AND CONTROL EQUIPMENT

Circle **113** on Reader Service Card

NEW PRODUCTS

flow control. A manually operated indicator permits selection of ten flow rates from a constant delivery pump.

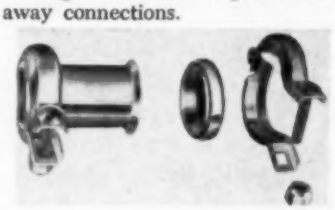


Specifications: Available in two sizes. Smaller has controlled flow range of 0 to 15 gpm with input of 15 gpm ;the larger up to 60 gpm with 80 gpm input.—*Fawick Hydraulic-Electronic Div., Cleveland*

Circle **311** on Reader Service Card

PIPE JOINT

To join plain pipe ends without machining pipe. Permits angular and axial pipe movement without leakage. Can be used as expansion or slip joint. Fastens with only one nut and bolt on each coupling end, making it suitable for quick-break-away connections.



Specifications: Pipe sizes from ⅜" to 4", lengths from 2" to 36". For 150-lb service. Temperatures from −40 to 250 F.
Designation: Flexmaster.—*Marman Div., Aeroquip, Los Angeles.*

Circle **312** on Reader Service Card

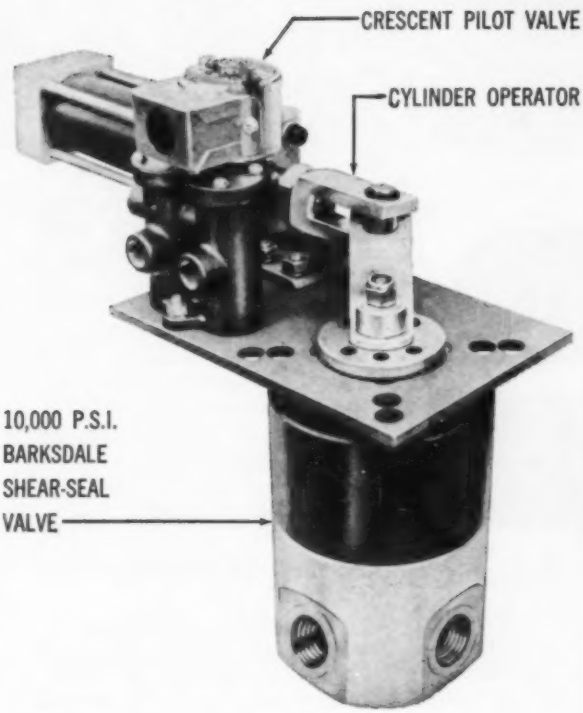
VALVE MOUNTED ON CYLINDER

Valve mounted on top of the air cylinder eliminates the air transfer tube, produces a faster response and reduces maintenance and servicing time. This manifold makes double-end-rod operation possible.

Continued on page 132

CYLINDER OPERATED

"SHEAR-SEAL" VALVES



Remote control operators for 10000 P.S.I., 6000 P.S.I. and 3000 P.S.I. "Shear-Seal" Valves are available with cushioned or non-cushioned cylinders.

4-Way, 3-Way and Shut-off valves range in pipe sizes from ¼" to 1 ½" N.P.T.

For complete data request catalog COV-60-61.

CONTROL VALVE DIVISION

Barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

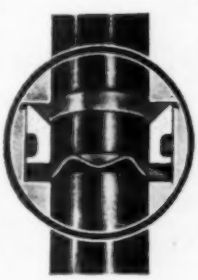
Circle 15 on Reader Service Card

AIR VALVE

FOR ORIGINAL EQUIPMENT MANUFACTURERS

250 P. S. I. four-way air valves in ¼, ⅜ and ½ inch pipe sizes.

NEW FACE LIFT results in LOWER PRICE



None of the operating advantages of this rugged *'Shear-Seal'* valve has been reduced one iota!

- . . . same non-corrosive construction throughout — eliminates failures due to rust.
- . . . same long wearing leak-proof qualities — metal to metal *'Shear-Seal'* design is not sensitive to dirt, compensates for wear.
- . . . same installation savings — because no oilers or filters are needed.

Only the exterior has been modified — tailored to the special preference of the Original Equipment Manufacturers — and, as a result, costs and prices have been substantially reduced. *Write for bulletin 5000 which includes design specs.*

CONTROL VALVE DIVISION

Barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

Circle 16 on Reader Service Card

IT'LL PERFORM BETTER IF IT'S *NYLAFLOW*® CODED!

NYLAFLOW PRESSURE HOSE
Special polyamide innertube
Braided hi-tensile nylon bonded to innercore
Abrasion resistant nylon cover
NYLAFLOW FREON HOSE
NYLAFLOW ANHYDROUS AMMONIA HOSE-4000 PSI BURST

■ Every foot of job-matched NYLAFLOW Pressure Hose is distinctly trademark-coded for quick identification of your "improvement in hose performance." Why engineer costly, bulky hose assemblies when there's a NYLAFLOW answer to your problem?

Highly resistant to flex and vibrational fatigue, NYLAFLOW is available in long, continuous lengths with burst pressure ratings from 4,000 to 12,000 psi. Inside diameters range up to ¼" and over with compact, lightweight assemblies if desired. Reusable or permanent fittings are available.

TYPICAL APPLICATIONS

1. Hydraulic, high pressure lube and pneumatic lines. NYLAFLOW is unaffected by both flammable and non-flammable hydraulic fluids.
2. Freon lines—NYLAFLOW has a remarkably low effusion rate for refrigeration and air conditioning products.
3. Solvent or hot paint lines of NYLAFLOW are unaffected by almost all organic solvents.
4. Anhydrous ammonia lines last indefinitely—when NYLAFLOW hose is used.
5. Pressure lines where electrical insulation is required.

Write today for details and illustrated brochure.

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Reading, Pa.

Engineered Industrial Plastics

NYLONS • TFE-FLUOROCARBONS • OTHER PREMIUM PLASTICS

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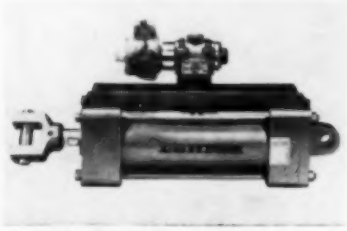
NEW PRODUCTS

Specifications: Cylinder can be mounted swivel, front flange, foot, clevis, and other ways. With double-acting, self-lubricating air cylinders, valve is available with sin-



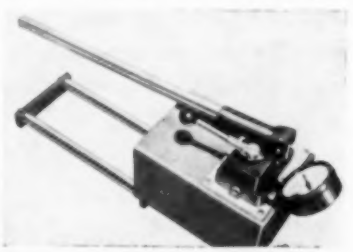
gle or double solenoids, momentary and maintained contact. In 1½", 2", 3", and 4" diameters. Larger diameters on special order.

Designation: Jockey series.—*Lehigh Inc., Air Controls Division, Easton, Pa.*

Circle **313** on Reader Service Card

2-SPEED HYDRAULIC HAND PUMP

Hand pump delivers 7.35 cu. in./stroke from 0 to 200 psi to move a cylinder piston quickly. When a load is encountered, it automatically changes to the high pressure stage, delivering 0.294 cu in./stroke from 200 to 10,000 psi.

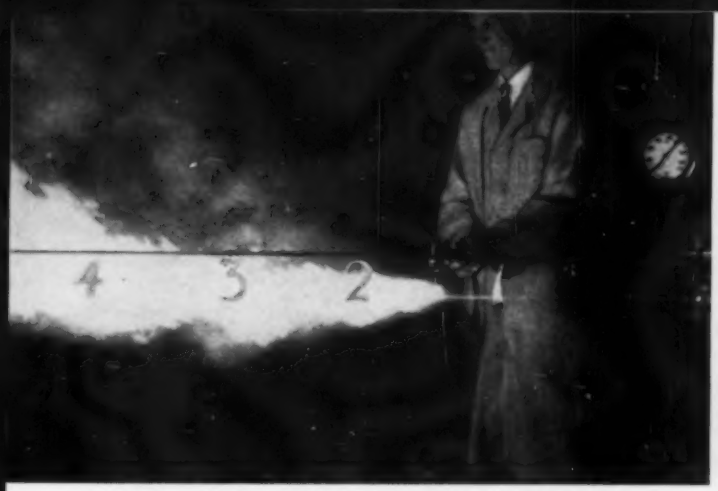


Pump and valving are mounted on a common cover plate which is removable from the unit's reservoir, permitting the unit to be used with other reservoirs. The mounting pad on the cover plate accepts either a 2-way or a 4-way valve for controlling either single- or double-acting cylinders.

Specifications: Weighs 34 lb. Measures 26½" x 8" x 12" high. Reservoir capacity is 2 gal.

Designation: Dualmaster Y-29 series.—*Owatonna Tool Co., Precision Hydraulics Div., Owatonna, Minn.*

Circle **314** on Reader Service Card



Ordinary hydraulic fluid made from mineral oil is ignited by open flame. Torch is 18 inches from nozzle orifice.

Shell Irus 902 Hydraulic Fluid, in the same test, refused to be ignited by 3000-degree flame.

BULLETIN:

3000-degree flame does not ignite Shell Irus 902—the fire-snuffing hydraulic fluid that helps make factories safe from fire

Shell forced Irus® 902 Hydraulic Fluid through a .145-inch orifice at 1000 psi pressure. The Irus Fluid was sprayed from the orifice and a 3000-degree flame thrust into the streaming fluid. Irus was not ignited.

Read the advantages of economical Shell Irus 902 and how it can protect your plant.

IRUS 902 is the fire-snuffing hydraulic fluid that protects lives and equipment.

How Irus works

Irus 902 is an ingenious combination of oil and water. The water is encased in a film of oil. In technical terms, it is a 100% water-in-oil emulsion.

But unlike other emulsions, Irus 902 has optimum stability. This is vitally important. It means that Irus Fluid will retain its lubricating qualities far longer than unstable oils—and will not allow the water to separate out. Result: the water stays in the oil, ready to snuff a fire if needed.

Other advantages

1. Cools off systems. Because of its high rate of heat transfer and high heat capacity, Irus 902 can allow hydraulic systems to run cooler.

2. Resists thickening and thinning. The viscosity of Irus 902 is tailored to protect pump parts during the entire working cycle—from cold start-up to hot, continuous operation.

3. Saves gaskets, packing, hose. Irus 902 is gentle to nonmetallic parts as well as metal. It can be used almost anywhere that you'd use mineral oil.

4. Resists foaming. Irus 902 does not hold captive air. If air is introduced, Irus 902 quickly releases it.

5. Easier to spot leaks. Irus 902 is bright yellow, helps you spot leaks quickly.

For complete details about changing over to Shell Irus 902, contact your nearest Shell Industrial Products Representative. Or write: Shell Oil Company, 50 West 50th Street, New York 20, N. Y.

A message to manufacturers of hydraulic equipment

Shell Irus 902 makes an excellent initial fill.

1. It is available anywhere in the U.S.A.

2. Quality of Irus Fluid is consistently high. It must meet strict Shell specifications.

SHELL

A BULLETIN FROM SHELL
—where 1,997 scientists are working to provide better products for industry.

Circle **136** on Reader Service Card

NEW PRODUCTS

DUAL PRESSURE VALVE

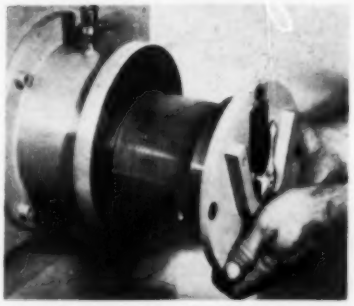
Two-stage, selector valve has non-interflow design which prevents fluid flow between ports when the valve is turned. Optically flat sliding seals wipe across the rotor. Sealing force is proportional to service pressure. Slight area-differential unbalance on the seals reduces turning torque at high pressures.

Specifications: Standard in ⅛", ¼", and 1¼" sizes, IPT. For water and hydraulic service. 105-degree handle turn, with 4 positions.—*Republic Mfg. Co., Cleveland.*

Circle **315** on Reader Service Card

SUBMERSIBLE FILTER

Tell tale, submersible, tank filter projects through a hole in the wall of the tank. Has a dirt indicator on its cover plate that shows when



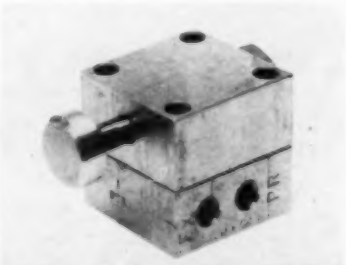
the filter needs cleaning. Can be cleaned from the outside without draining the tank. Outlet pipe can go in any direction through the tank.

Specifications: Available in 30, 60, 100, and 200 gpm capacities. All are aluminum. The 30 and 60 have no intake pipe connection and are to be submerged, as illustrated. The 100 and 200 have an intake connection and are for external (line) use, especially where pumps are below oil level.—*The Rosaen Company, Hazel Park, Mich.*

Circle **316** on Reader Service Card

HYDRAULIC GAUGE ISOLATOR

Two new engineering data sheets describe the gauge isolator which is a normally-closed, spring-returned, 3-way valve. Has integral orifice for snubbing action. Depressing a button opens the pressure line to the gauge. Releasing button closes the line and drains the gauge to tank. Data sheets have schematic drawings, typical circuit applications, flow characteristics, JIC diagrams, and dimensions.



Specifications: For hydraulic and other non-corrosive liquids and pressures to 5000 psi. Small and light. Sub-plate mounting or with ¼" NPTF ports for inline mounting.

Designation: Series 1200.—*Sarasota Precision Products, Inc., a subsidiary of Racine Hydraulics & Machinery, Inc., Sarasota, Fla.*

Circle **317** on Reader Service Card

DEPENDABILITY

THESE HANDS MOLD precision hydraulic cylinder components. Their years of experience skillfully extract quality parts from raw stock—your guarantee of dependability. These adroit hands dare to test their skill with rigid, station-by-station inspection. Every cylinder conforms to the industry's highest standards. CROSS hydraulic cylinders are designed and built for varied, rigorous industrial applications. Write today for specifications. If it's not in stock, CROSS will customize a unit to fit your need.

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CROSS Engineers Available to You for Free Consultation!

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SURGEPRUF®

hydraulic components reduce replacement time, give longer service!

Whatever the product, installation or application, use Surgepruf hydraulic components if you want the best! Surgepruf Non-Skive Hose and Shur-Lock Reusable Couplings reduce replacement downtime by offering fast, easy, on-the-job replacements. Surgepruf Non-Skive Hose eliminates the need to remove outer rubber cover. Shur-Lock Couplings may be reused by removing old hose and reassembling on a new one. Together they provide one quick, simple assembly without mandrels or special tools.

Surgepruf "Swaged-on" assemblies can be supplied in any dimensions for any application you name! Low, medium, medium-high and high pressure assemblies will be provided to your exact specifications. Each is factory-assembled to speed-up replacement, each will provide the finest leak-proof seal with no braid exposure.

All Surgepruf hose meet SAE Hydraulic Standards for working pressure and burst requirements. Hose temperatures range from −40°F. to plus 275°F. The complete selection of Surgepruf hydraulic components – Shur-Lock and "Swaged-on" assemblies, reusable couplings, hose, adapters and connectors – are available nationally through your local Alemite Company and leading Industrial Distributors.

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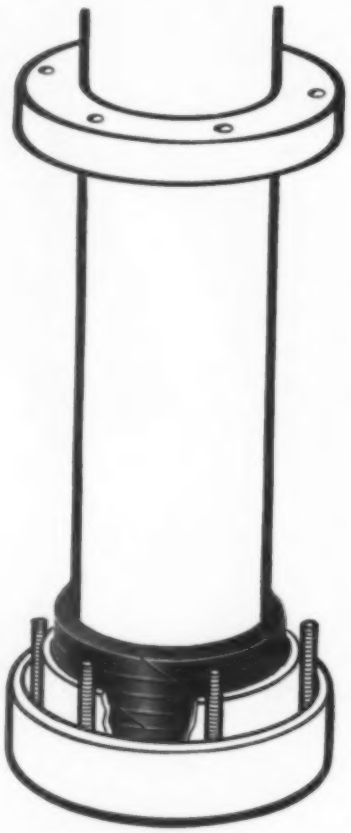


R/M CAPABILITY PRODUCES VEE-FLEX® PACKINGS

for positive sealing against all hydraulic and pneumatic pressures

Whether you are designing pumps, valves, hydraulic cylinders, rams, presses, shock absorbers or similar equipment—R/M Vee-Flex Packings will more than meet your requirements. They provide a positive seal against all hydraulic and pneumatic pressures used in industrial equipment. They give outstanding service against air, water, steam, petroleum products, other commercial fluids, and food products. Designers are especially interested in these characteristics:

- Self-adjusting
- Require only finger-tight gland adjustment
- Longer life with fewer adjustments
- Available in combinations of materials, including various elastomers, duck and asbestos, solid Teflon,* Teflon-impregnated

Write for your copy of new Catalog P-100 which contains complete details.

**Registered trademark for Du Pont fluorocarbon resins*

RAYBESTOS-MANHATTAN, INC.

R M PACKINGS

PACKING DIVISION, PASSAIC, N.J.

MECHANICAL PACKINGS AND GASKET MATERIALS

Circle **124** on Reader Service Card

NEW PRODUCTS

FLOW REGULATORS

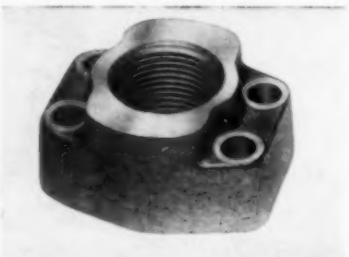
Simple design, low cost flow regulator to regulate flow in one direction with free flow in the other. Standard models with ¾ or ¾ in. pipe thread ports. SAE straight threads also available.

Specifications: Nominal free flow to 20 gpm. Maximum controlled flow rate for both sizes is 10 gpm. Pressure 3000 psi. Two-piece adjusting screw allows adjustment under pressure with no leakage.—*Vickers Inc. Div. Sperry Rand Corp., Detroit.*

Circle **318** on Reader Service Card

O-RING PIPE THREAD FITTING

O-ring pipe thread fitting with NPTF female thread will go on standard pipe and provide connections from pipe to SAE, 4-bolt, flange type connectors, thus eliminating thread type connections.



Specifications: Sizes from ¼" to 3". —*Anchor Coupling Co., Libertyville, Ill.*

Circle **319** on Reader Service Card

SOFT-SEATED VALVE & FITTING SEALS

Soft-seated valve has seals that assure positive valve shut-off at pressures to 6000 psi and temperatures from −20 F to 275 F. O-rings give

leakproof valve connections, and unions can be made or broken with only slight hand torque.

Specifications: Two complete lines: for 1500 psi and 6000 psi. Liquid or gas service in sizes from ¼" to 2".

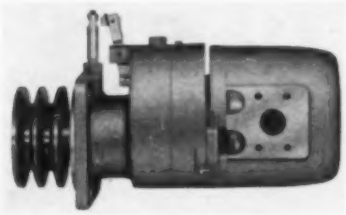
Designation: O-Seal System.—*Combination Pump Valve Co., Philadelphia.*

Circle **320** on Reader Service Card

HYDRAULIC PUMP & CLUTCH

Hydraulic gear pump combined with a remote-controlled, rugged clutch eliminates the need for a power-take-off. Designed for belt, gear, or direct drive, it accepts engagement speeds (no load) from idle to 2200 rpm.

Specifications: Outputs from ⅓ hp to 30 hp and flow rates from 1.7 to 26 gpm. The clutch is available in 2 series: C-100 weighs 9 lb and has 4 models. C-200 weighs 19 lb and has 3 models. All available for either cw or ccw rotation.

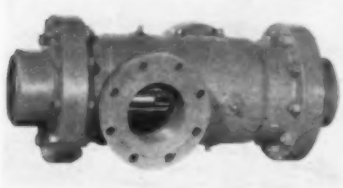


Designation: Touch-O-Matic.—*Berry Hydraulics, a division of Oliver Tyrone Corp., Corinth, Miss.*

Circle **321** on Reader Service Card

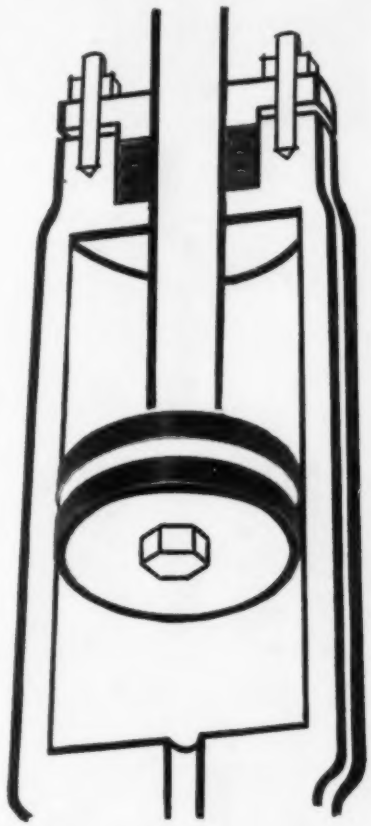
HIGH CAPACITY AIR VALVES

Large, high flow capacity air valves in sizes up to 8 in. and for pressures to 250 psi have hollow ported plungers and resilient U-packer design. Large air valves eliminate the need for multiple valving or system redesign to suit flow availabilities. Air flow capacities range to



32,000 cfm at 100 psi pressure drop.—*Hunt Valve Co., Salem, Ohio.*

Circle **322** on Reader Service Card



R/M CAPABILITY PRODUCES PRECISION PISTON CUPS

for sure sealing and high resistance to extrusion

Consider these important advantages of R/M piston cups. They are designed and precision molded to assure dimensional uniformity and maximum sealing efficiency. R/M uses a processing technique that gives deep fabric impregnation. They offer minimum friction and maximum resistance to extrusion. Of particular interest to designers are the following advantages:

- R/M piston cups are made in standard sizes to fit cylinders ranging in diameter from ½ to 12 in.
- R/M piston cups are molded in varying degrees of hardness and in combinations of materials including various elastomers, duck and asbestos, solid Teflon* and Teflon-impregnated

For complete data, including service recommendations, write for our new Mechanical Packings and Gasket Materials Catalog P-100. It covers R/M piston cups to suit all your most exacting needs.

*Registered trademark for Du Pont fluorocarbon resins

RAYBESTOS-MANHATTAN, INC.

R/M PACKINGS

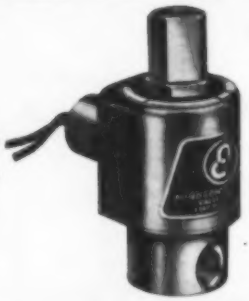
PACKING DIVISION, PASSAIC, N.J.

MECHANICAL PACKINGS AND GASKET MATERIALS

Circle **125** on Reader Service Card

NEW

3-WAY BRASS MINIATURE SOLENOID VALVE



COSTS LESS

THAN COMPARABLE VALVES

FEATURES

Unique new simplified design
Extremely long reliable life
Quiet, cool operation

PERFORMANCE

Pressure Rating: (std) to 200 psi, Special to 500 psi

Orifice Diameter: (max) 5/32 in. by 3/32 in.

Porting: ⅛ in. NPT

Coil Voltage: (std) class A 115 or 230 volt a-c 60 cps Special class A, B, C or H for any voltage up to 220 volts d-c or 440 volts a-c 60 cps

Media Temperature: −45°F to +150°F

Immediate delivery on standards
Wide range of optional variations
For complete information write for Bulletin 303

AL-217

ALLIED CONTROL

ALLIED CONTROL COMPANY, INC.

VALVE DIVISION

2 EAST END AVENUE, NEW YORK 21, N. Y.

Circle **25** on Reader Service Card

PRODUCT BRIEFS

AIR & HYDRAULIC CYLINDERS . . . These cylinders feature full cartridge rod bearing, and meet JIC interchange requirements. Improvements include a cartridge rod bearing that incorporates a metal rod scraper and a rubber rod wiper. They are offered in 1½, 2, 2½, 3¼, 4, 5, 6, 8, 10, 12, and 14" bore sizes, and are for 200-psi air and 250/500-psi hydraulic service.—*Carter Controls Inc., Lansing, Ill.*

Circle **323** on Reader Service Card

RIGID TUBE COUPLING . . . The Dynatube high temperature, high pressure, rigid tube coupling provides absolute dynamic sealing for all liquids and gases up to 700 F, and 1000 F for certain uses. It remains leak-proof under cyrogenic conditions. Available in sizes from—3 through—24.—*Resistoflex Corp., Roseland, N. J.*

Circle **324** on Reader Service Card

REUSABLE FITTINGS . . . Hoze-lok reusable fittings are now provided for the company's Series 40 medium pressure hose and Series 30 double wire-braid hose for high pressure. The line includes an end having a swivel nut to mate with Ferulok bite type tube fittings. Hose cover does not have to be skived.—*Parker Fittings & Hose Div., Parker-Hannifin Corp, Cleveland.*

Circle **325** on Reader Service Card

Accurate, Automatic temperature control

OF HYDRAULIC AND HEAT TRANSFER FLUIDS

Peak performance of hydraulic equipment is assured by the precise, dependable oil temperature control maintained by the Sterlco Temperature Control Valve, Series 150E. It's completely automatic, self-contained, compact and low cost . . . operates in any position. Write for details.

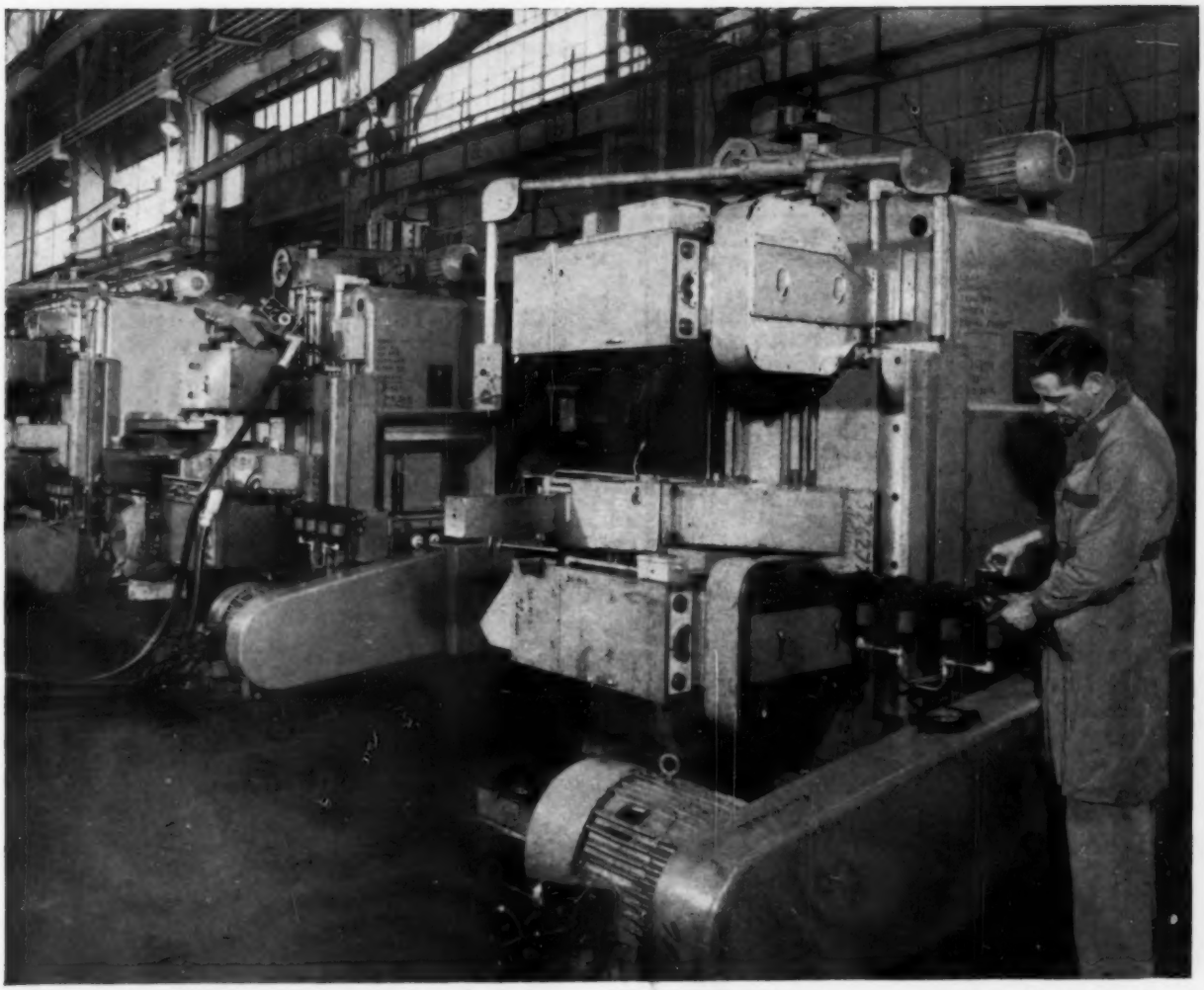
Sterlco®
Temperature Control Valve
Series 150E

Leaders in temperature controls since 1916

Sterling inc.

5202 West Clinton Avenue Milwaukee 23, Wis.
Industrial Control Division

Circle **139** on Reader Service Card



New 10-micron filtration for both hydraulic and lubricating systems of re-designed Bullard dynatrol vertical turret lathe. Made of resin-impregnated, waterproof paper, Purolator Micronic filters withstand a differential pressure of 75 psi . . . temperatures up to 275°F.

PUROLATOR MICRONIC® FILTERS IMPROVE FILTER EFFICIENCY 270% ON NEW BULLARD COMPANY TURRET LATHE AND BORING MILL

Ten micron filtration assures maximum operating efficiency and long equipment life. "Tolerances are a lot closer on our new vertical turret lathe and horizontal boring mill," says Bill Glynn, Project Engineer for Bullard. "Parts like the new hydro mesh feed brackets and solenoid valves would wear out fast if we used the old steel filters which only filter down to 37 microns."

Used for both hydraulic and lubricating systems. "We upped filtration efficiency some 270% by installing Purolator Micronic filters on both hydraulic and lubricating systems.

"With this new 10-micron full-flow filtration we should get the best possible performance from our new equipment."

Element replaced only every 1000 hours. "Replacing the Micronic filter element takes only a minute," Glynn goes on to say. "And since a new one is needed only every 125 8-hour working days or so, we feel these new filters will cut downtime and production costs, too."

Ideal for precisely-finished new equipment. Reliable, full-flow filtration down to 10 microns means that Purolator Micronic filters give maximum protection to precisely-finished new equipment. These same filters can also mean improved performance and longer service life from existing equipment.

For full information, contact your nearest Purolator Sales Office, or write: Purolator Products, Inc., Rahway, N. J.

Filtration For Every Known Fluid

PUROLATOR
PRODUCTS, INC.

RAHWAY, NEW JERSEY AND TORONTO, CANADA

Circle **120** on Reader Service Card

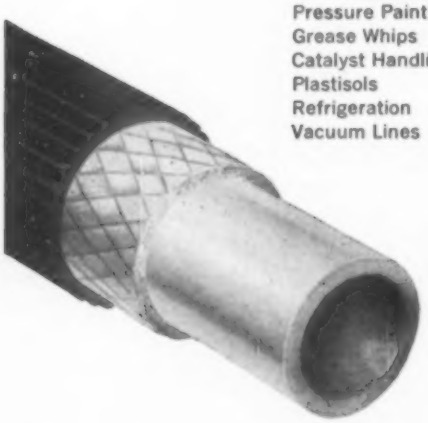
Versatile

SYNFLEX PRESSURE HOSE*

now handles them all

WHAT'S YOUR APPLICATION?

Hydraulics — Conventional and nonflammable fluids
Pressure Paint Spraying
Grease Whips
Catalyst Handling
Plastisols
Refrigeration
Vacuum Lines



WHAT'S YOUR PROBLEM?

Air	Grease
Water	Anti-Freeze
Fuels	Freon-12
Hot Oil	Freon-22
Gasoline	Skydrol
Butane	Sunlight
Propane	Abrasion

*Synflex Pressure Hose is an entirely new—and fully proven—departure in pressure hose design and manufacture. There's nothing—absolutely nothing—like Synflex Pressure Hose.

Synflex Pressure Hose construction is comprised of a precision-drawn special polyamide formulation core tube, a tough braided plastic covering for burst resistance, and an extruded polyamide outer sheath to form an homogenous tube structure. Result: lightweight, flexibility, chemical and abrasion resistance.

Synflex Pressure Hose is competitively priced, more than meets all requirements of SAE Specification 100R1. Write for literature and sample length of Synflex Pressure Hose TODAY.

A-2129A

SYNFLEX
Products Div.
Samuel Moore & Co.
Mantua, Ohio

Circle **103** on Reader Service Card

PRODUCT BRIEFS

200-PSI CYLINDERS . . . Low-cost cylinders available in 1½", 1½", 2", 3", and 4" bore sizes. Chrome-plated steel piston rods. Interchangeable mountings and rectangular feed ring locking of heads to cylinder barrels.—*Modernair Corp., San Leandro, California.*

Circle **330** on Reader Service Card

RECYCLING TIMER . . . Produces a series of "on" and "off" electrical pulses. Interval of both signals easily adjustable. Interchangeable timing elements. Operable on either 115 or 230 volts at 50 or 60 cycles. Series Dual-Trol—*Industrial Timer Corp., Newark, N. J.*

Circle **331** on Reader Service Card

MINIATURE BALL VALVES . . . Pressure rating, 1000-psi. Sizes ⅛", ¼", ⅜", and ½". Teflon seats and packing. Rotation sensitivity of valve handle suits valve for critical control of fluid flow.—*Valve & Fitting Div., Cooper Alloy Corp., Hillside, N. J.*

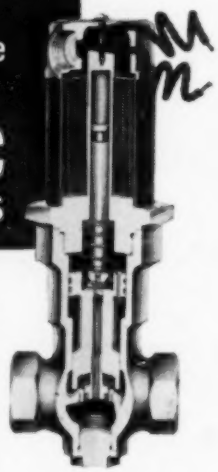
Circle **333** on Reader Service Card

PNEUMATIC CALCULATOR . . . Calculates cylinder bore size required for any load, force produced by any cylinder, speed of stroke of any cylinder at any air pressure, compressed air requirements for any cylinder, and how to size pneumatic components such as valves, hose, etc.—*Flow Finder, Westfield, N. J.*

Circle **85** on Reader Service Card

for a long life of dependable, trouble-free service, *specify*

ATKOMATIC
SOLENOID VALVES



Available in bronze and stainless steel for pressures from zero to 10,000 psi . . . temperatures from minus 350°F to plus 500°F . . . pipe sizes from ⅛" to 3" . . . for corrosive and non-corrosive gases, liquids and vapors.

More than 20 years of engineering experience and manufacturing skill go into the construction of each ATKOMATIC Solenoid Valve. Before shipment, valves are factory-tested on special flow lines *under actual operating conditions* to insure functional integrity and long, maintenance-free service. Experience and skill . . . combined with exacting quality control . . . give you a lifetime of safe, reliable, *low-cost* operation.

Atkomatic
VALVE COMPANY, Inc.
545 WEST ABBOTT STREET
INDIANAPOLIS 25, INDIANA

write for Atkomatic Catalog no. 444

Circle **11** on Reader Service Card

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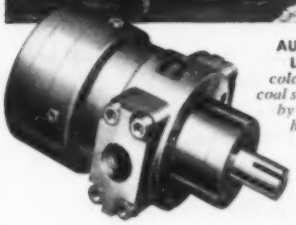
DENISON HydrOILics

Rugged, dependable
DENISON hydraulic equipment
powers automatic leveling system
on giant new **MARION** shovel...

BIG DAVID



AUTOMATIC HYDRAULIC LEVELING *on Marion's colossal new "Big David" coal stripping shovel is done by electrically-controlled hydraulic jacks at each corner of machine. Hydraulic power is provided by two Denison 800 series Constant Volume Axial Piston Pumps.*

BIG DAVID—newest of the huge coal stripping shovels built by Marion Power Shovel Company—is operating at one of the Peabody Coal Company's mines near Macon, Missouri. Higher than a 16-story building, this giant machine is designed to uncover the coal seam *fast*. Its great dipper can scoop up 65 cubic yards of overburden in one bite.

To keep this colossus level—and thus equalize the load as it moves over uneven terrain—adjustable hydraulic jacks are installed above the crawlers at each corner of the main frame. Hydraulic power for these four automatic, electrically-controlled jacks is supplied by Denison 5000 psi hydraulic pumps and controls.

Automatic leveling on this million-dollar Marion machine permits production to continue without interruption for leveling, *saves hours of downtime on the job*. Smooth, dependable Denison power assures instantaneous response . . . trouble-free service . . . low maintenance . . . *profitable operation*. And Denison hydraulic components have helped chalk up records of high performance and reliability for other large Marion shovels.

Ask your nearby Denison Hydraulics Specialist to show you how Denison hydraulic equipment—pumps, motors, valves, controls—can help simplify your design, cut costs, increase dependability. Write, wire or phone today.

DENISON ENGINEERING DIVISION
American Brake Shoe Company
1166 Dublin Road • Columbus 16, Ohio

HYDRAULIC PRESSES
PUMPS • MOTORS • CONTROLS

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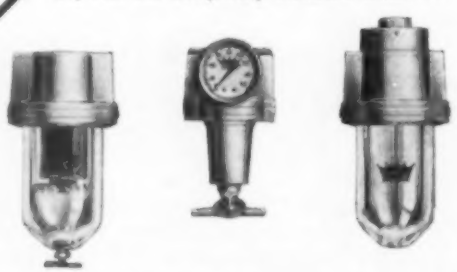
HYDRAULIC POWER

HANNIFIN *Crown*

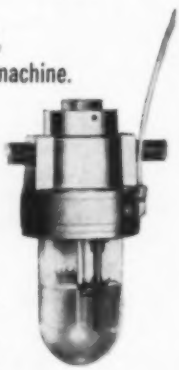
delivers air the way you want it!

With "Crown" remote controlled units, you can filter and drain overhead air lines, control regulators from below, and fill lubricators without climbing.
Or, with our completely standard units . . .



. . . you can provide just the right amount of filtered, regulated and/or lubricated air right at your machine.

NEW! **PULSE-LUBE . . . for off-beat air flow**



If air flow is uphill or light or so infrequent that air-borne lubrication won't solve your problem, you can deliver oil just where you need it, in the exact amount you need, through a tiny flexible tube with new "Crown" Pulse-Lube . . .

All these "Crown" developments are detailed and described in a new, comprehensive "Crown" catalog (our Bulletin 0400-B1). We'll be happy to send you one.

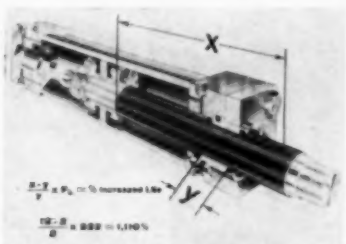
PARKER-HANNIFIN
HANNIFIN COMPANY DIVISION
545 South Wolf Road • Des Plaines, Illinois
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS
EUROPEAN DIVISION - PARKER-HANNIFIN N.V. - SCHIPHOL - THE NETHERLANDS

Circle **64** on Reader Service Card

NEW PRODUCTS

BRONZE-COATED PISTON AND GUIDE RODS

High quality, bearing bronze is fused on the surface of a steel rod that is then ground and straightened to very close tolerances. This bronze-coated rod in combination with hardened steel bushings substantially reduces production downtime and the cost of bushing and rod replacements. Bronze bearing material is put on the large area of the shaft instead of being confined



to the bearing area within the bushing, so wear is spread over a large area. Fusing is done by high-temperature spray which forms a coating of controlled porosity for excellent lubricant retention, so friction losses are reduced.

Specifications: Bronze rods, furnished from a stock of standard material, AISI 1060, heat treated. Standard diameters from ¾" through 3". The diameter tolerence up to 2" is +0000, −.0005". For 2" and over, +0000, −.0007". Other diameters and tolerances to special order. For many applications standard, hardened steel die set bushings are immediately available from local supply houses.

Designation: Bronze Case—*Thomson Industries, Inc., Manhasset, L. I., N. Y.*

Circle **334** on Reader Service Card

DIRECTIONAL CONTROL VALVES

Solenoid, pilot-operated, heavy duty, directional control valves have solenoids totally enclosed and sealed. Stem in solenoid cover permits manual pilot valve operation. Pilot valve has a built-in check and adjustable choke, allowing free

flow-in to shift the directional plunger away from the operator valve, and restricted flow-out when the plunger is shifted toward the operator valve. Alloy iron bodies contain large curved core channels. Bodies are bored for spools and ports are machined.

Specifications: Available in ¼" through 3" pipe sizes for pressures to 3000 psi (some 5000 psi) and in 2-, 3-, and 4-way valves. Have many combinations of pilot valves and spring-centering. Many standard spools and over 160 special spools.—*The Oilgear Company, Milwaukee.*

Circle **332** on Reader Service Card

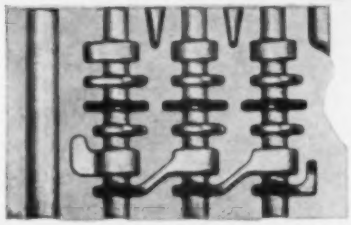
TUBE, ROD & PIPE END FINISHING

Double-end finishing machine simultaneously finishes both ends of tube, rod, pipe, or similar workpieces up to 3" in diameter in lengths to 120". Typical operations include inside-outside deburring, chamfering and facing, and other light forming or pointing work. The machine produces from 2400 to

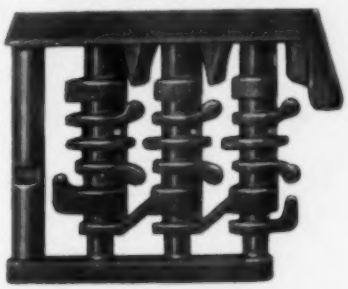
Continued on page 145

Circle **163** on Reader Service Card

An improved product at minimum end cost with Dalton castings design assistance!



SECTIONED VALVE BODY



SHELL CORE

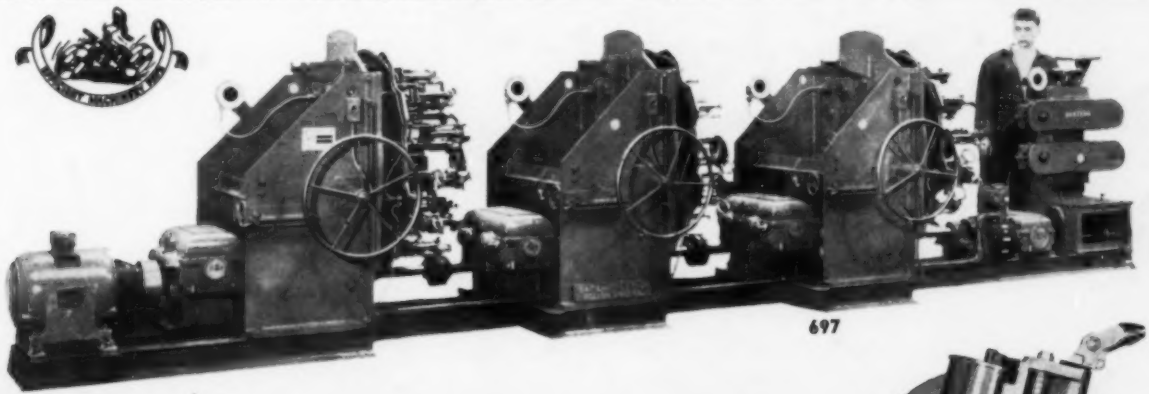
The Brown & Sharpe/Double A Mobile Valve is a versatile, electrically controlled hydraulic valve for modern mobile equipment. Dalton Engineers worked closely with the customer to develop a cast iron valve body with ideal performance characteristics at lowest possible cost.

Intricate coring was necessary and Dalton's shell core facilities insured smoother, cleaner passages, greater accuracy. Exterior surface was contoured for even wall section thickness, and proper micro structure.

Dalton quality control maintains physical properties well above minimum requirements in this casting designed for Class 40 Gray Iron. Double A Products Co., Manchester, Michigan, is pleased with the results!

Specialization in pressure type castings with the engineering, production and quality control facilities to **guarantee the tensile strength requirement for the piece to be in the casting** . . . and give you an improved product at minimum end cost . . . leads us to reason that The Dalton Foundries is "Where Values Are Cast!" Write for brochure . . . see our specialist in hydraulic castings.

THE DALTON FOUNDRIES, INC., WARSAW, INDIANA



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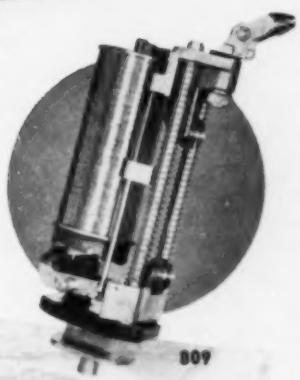
30% MORE PRODUCTION

OF HIGH PRESSURE HOSE

WITH THE NEW "HIGHLOAD" WIRE CARRIER!

Up To 28 Lbs. Tension With A Quietly Controlled Package of 7 Lbs. of Wire.



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WORLD PATENTS APPLIED FOR

For further details write: MACHINERY DIVISION

B. & F. CARTER & CO., LTD. ALBION WORKS BOLTON, ENGLAND.

ELECTRIC CABLE, FLEXIBLE TUBE & PIPE, BRAIDING AND WIRE ROPE MACHINERY OF EVERY DESCRIPTION.

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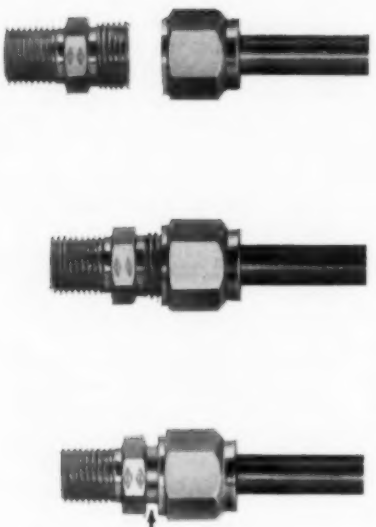
Circle **23** on Reader Service Card

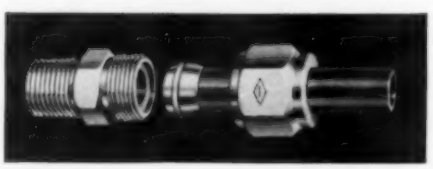
you can see see see when it's tight



With Hi-Seal you can *see* that hazards are not installed in your tubing system. When the threads no longer show, the connection is pressure-tight. No other fitting offers this advantage.

This means an easy, foolproof assembly that is inspected with just a glance. Anyone who can handle a wrench can make a dependable Hi-Seal joint every time. No need for assembler to count wrench turns. No over- or under-tightening to worry about.

Hi-Seal flareless assemblies are made faster, more economically, more surely. Specify Hi-Seal tube fittings.



BUTT JOINT **HI-SEAL**

IMPERIAL EASTMAN

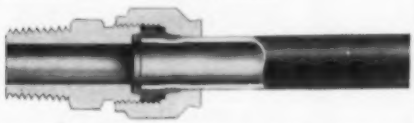
Imperial-Eastman Corporation General Offices: 6300 West Howard Street, Chicago 48, Illinois

Circle **79** on Reader Service Card

see

many reasons why you're ahead with HI-SEAL®

Seeing when they're tight is only one reason for preferring Hi-Seal fittings. Of course, this is a big one for fast, positive inspection and for design engineers who want leakproof, foolproof connections in any system.



Withstand vibration, high pressure — Hi-Seal fittings provide firm tube support for excellent vibration resistance. The fitting is a grip type, rather than a bite type. Three serrations in the sleeve establish the grip without damaging or weakening the tube.

When assembled, Hi-Seal fittings give you a pressure-tight seal compatible with the tubing required. For extreme pressure ranges, Braze-Seal fittings give make and break flexibility.

Make and break 25 times — Simple assembly and re-assembly of Hi-Seal butt-joint fittings mean greater re-use. Hi-Seal's standard is 25 re-uses. The industry standard is 15—or 66⅔% more for Hi-Seal.

Close bends — Butt-joint H-Seal fittings make close bends possible. Reduce space, material by as much as a half!

One fitting for entire system — Hi-Seal is the most versatile fitting you can use. By standardizing on Hi-Seal, installation and maintenance men can plumb a job fast, yet perfectly, in any pressure range. Available in all styles and combinations, plus a variety of metals—steel, stainless steel, brass, aluminum, titanium, Monel, etc.

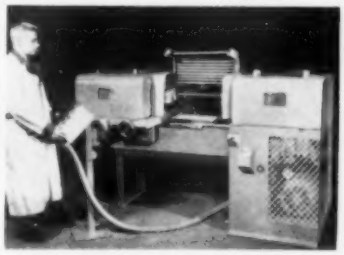
Now Imperial-Eastman meets *all* your fluid piping requirements—tube fittings, valves, couplings, flexible and rigid hydraulic lines, thermoplastic tubing, and tubing tools.

FITTINGS

IMPERIAL-EASTMAN

NEW PRODUCTS

3000 finished ends per hour to close tolerances. Workpieces are automatically fed into machining position, and other operations of

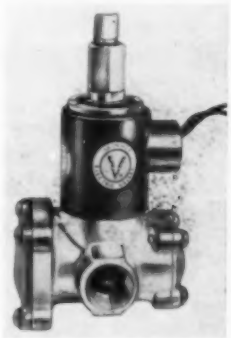


the machine are completely automatic too. Set-up is very fast and easy—*Pines Engineering Co., Inc., Aurora, Ill.*

Circle **335** on Reader Service Card

EXPLOSION-PROOF SOLENOID VALVES

In 3-way normally open, normally closed, and directional control. Class I—group D used in atmospheres such as gasoline vapors. Class II—group F, coal and coke dust. Class II—group G, grain dust. **Specifications:** ¼" main orifice and ½" NPTF ports. Pressures from 5 to 150 psi. ½" NPT conduit housing. L series valves have naval



forged brass bodies, brass and stainless steel internal parts.—*Skinner Electric Valve Div., Skinner Precision Industries, Inc., Hartford, Conn.*

Circle **336** on Reader Service Card

LONGER PISTON ROD ENDS

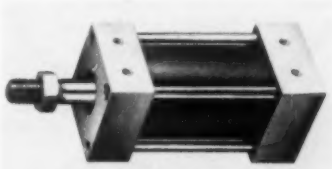
Double-length piston rod ends are offered as an optional standard at no extra cost on air and hydraulic cylinders. Provides twice the metal and twice the number of threads for securing attachments to the rod end.

Designation: 2L.—*Miller Fluid Power Div., Flick-Reedy Corp., Bensenville, Ill.*

Circle **337** on Reader Service Card

CHROME-PLATED AIR CYLINDER

Chrome-plated, steel barrel for 250-psi air cylinder is roller-burnished to a 4-microinch finish. Has low-friction nylon and Delrin bearings. Cylinder heads are of high-tensile strength aluminum, and the piston rod is heat-treated, stainless steel, which is ground and burnished. Self-adjusting, block-V piston rod and rod packings automatically compensate for pressure variations. Unique cushion arrangement has a



cadmium-plated spring, spherical radius seal, and chamfered seat. Exceeds all JIC standards. Catalog available.

Designation: Series D.—*Alkon Products Corp., Hawthorne, N. J.*

Circle **338** on Reader Service Card

TESTER AND CALIBRATOR

Portable, high pressure tester and calibrator is a pneumatic-hydraulic inspection device. For pressures from 5 psi to 10,000 psi. Model 1372. A series of data sheets on applications available.—*American Research and Manufacturing Corp., Rockville, Md.*

Circle **339** on Reader Service Card

DIRECTIONAL CONTROL VALVE

For use with oils and non-corrosive fluids or lubricated air. Four-way valve, can be actuated by rotary actuator.

Specifications: Shop air at 100 psi to actuator will provide torque to index valve controlling a 2000-psi hydraulic circuit. In ¼", ⅜", and ½" pipe sizes.

Designation: Spherotor.—*Sarasota Precision Products, Inc., Sarasota, Florida.*

Circle **340** on Reader Service Card

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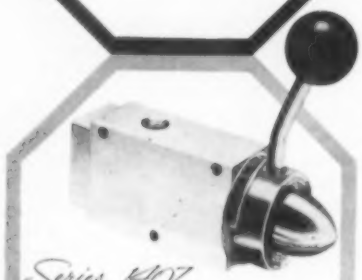
WATERMAN



FLOW REGULATORS

Full range Adjustable *Pressure Compensated* Flow Control *to 5000 p.s.i.*

Waterman Series 1407 is a group of compact, low-cost, pressure-compensated flow regulators, adjustable over a series of unusually wide flow ranges, for convenient on-the-job speed control of hydraulic cylinders and motors.

Rated for pressures to 5000 p.s.i.

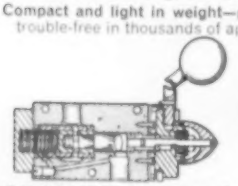
Controlled flow to 40 g.p.m.—ideal for hydraulic motors as well as cylinders. Factory-tested to 10% tolerance.

Wide range of adjustability—turndowns of as much as 80 : 1.

Choice of mountings and operating devices.

½" N.P.T.F. size meets most needs—standard sub-plate mountings available.

Compact and light in weight—proved to be trouble-free in thousands of applications.



Unit senses pressure drop across variable orifice and reacts to control flow within desired limits.

W-6120

Send today for new Catalog 1002.

WATERMAN HYDRAULICS CORPORATION

725 Custer Ave., Evanston, Ill.

Circle **149** on Reader Service Card

NEW LITERATURE

Continued from page 58

FLARLESS TUBE FITTINGS

Fittings have three parts including a body, reversible ferrule, and nut. Nuts slide around tubing bends for easy assembly. All seals are metal-to-metal. Fittings can be used with brass, copper, steel, aluminum, stainless, and most plastic tubing. Assembled with standard tools. Large contact area with the tube dampens vibration and prevents critical stress concentration. Leak-proof beyond the burst pressure of the tubing. Catalog 1-25. *AFCO Fitting Co., Cleveland.*

Circle **414** on Reader Service Card

DIRECTIONAL VALVES

Solenoid, pilot-operated 2- and 3-way directional control hydraulic valves for 3000 psi are described in a 4-page bulletin. Information includes construction, dimensions, specifications, flow diagrams, and ASA symbols. Valves are bracket and panel mounted with ⅜" NPT ports, normally-open or normally-closed. Also covered are ⅜" and ½" pilot operator valves with built-in check valve and adjustable choke for restricting flow into the operator port. *The Oilgear Co., Milwaukee.*

Circle **415** on Reader Service Card

PRESSURE SNUBBERS

Engineering bulletin covers porous metal snubbers for instrument protection, steady pressure gage readings, and increased instrument life. Includes scale drawings to aid designers in layout. Made in ⅛", ¼", and ½" NPT with maximum pressure ratings to 20,000 psi. Excess flow check snubbers prevent escape of gas or liquid if an instrument ruptures. Snubbers are also used for metering small flows. *Chemiquip Co., New York.*

Circle **416** on Reader Service Card

FILTER CARTRIDGES

Use Fuller's earth or cellulose filtering media. Made in standard

Continued on page 148

Circle **82** on Reader Service Card

NEW HEAVY DUTY TYPE KEBBY TANK-TRAPPER

. . . low cost magnetic unit for hydraulic reservoirs

- "DOUBLE MAGNETIZATION"
- CUTS MACHINE DOWN TIME
- REDUCES MAINTENANCE
- MORE DURABLE
- MASSIVE APPEARANCE

Write, wire or phone WO 3-1466 for information and prices.

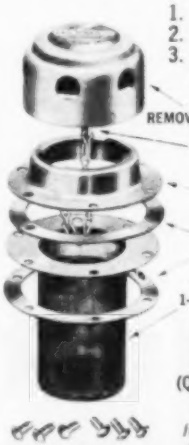
KEBBY COMPANY

2320 Custer Ave. • Rockford, Illinois

MANUFACTURERS OF MAGNETIC DEVICES

FILLER-BREATHER

3-way protection for hydraulic system reservoirs



1. Breathing
2. Air filtering
3. Straining hydraulic oil as it is added.

REMOVABLE AIR FILTER CAP

JIC SAFETY CHAIN NOW INCLUDED

ADAPTER

GASKETS

BRASS SCREEN 1-15/16" DIAMETER

SELF TAPPING SCREWS

MODEL A-100

Each: $4.00

(Quantity Discounts)

To order or for further information wire or write . . .

"Controlled Fluid Horsepower"

PAUL - MUNROE HYDRAULICS

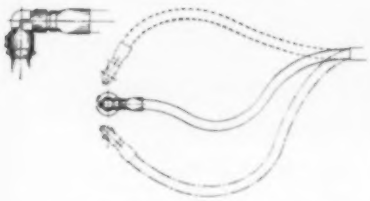
6430 East Gage Avenue

Bell Gardens, California

Circle **114** on Reader Service Card

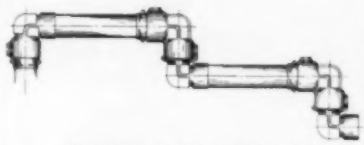
HERE ARE 3 COMMON LINE DESIGN PROBLEMS CHIKSAN SWIVEL JOINTS CAN HELP YOU SOLVE

1 **Shorten hose radii, reduce torsional stress.**



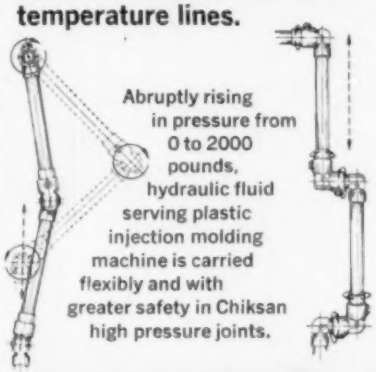
Flexible head on this lens grinder is hydraulically powered. Joints shorten required hose lengths. Hose would otherwise need suspension to keep out of way.

2 **Predetermined flex of piping between two or more points.**

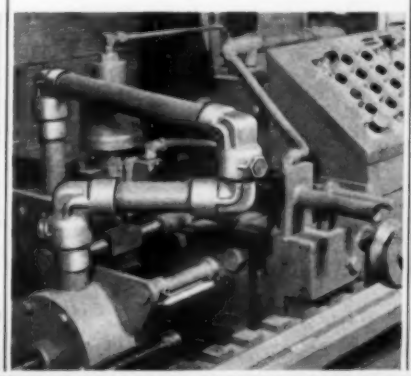


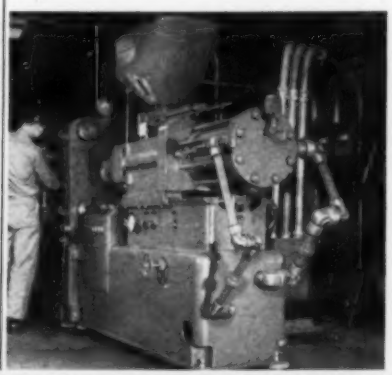
Pressure testing of pipe is nearly automatic as hydraulically driven supply heads close on pipe ends. Dog-leg jointed pipe moves back and forth continuously, safely.

3 **Achieve maximum safety of flexible high pressure, temperature lines.**

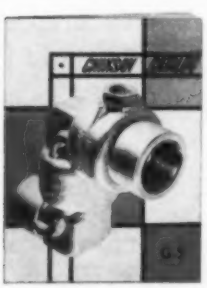


Abruptly rising in pressure from 0 to 2000 pounds, hydraulic fluid serving plastic injection molding machine is carried flexibly and with greater safety in Chiksan high pressure joints.





Studied consideration will quickly show that Chiksan swivel joints have numerous applications. Whenever you have a piping situation where movement is required, the benefits of swivel joints should be weighed. As illustrated above, Chiksan swivel joints have great versatility. They give added life and adaptability to rubber hose. They give metal lines a rubber-like flexibility. They help relieve stresses imposed by expansion, vibration or misalignment. Chiksan swivel joints, with their full 360° rotation and high service life, quickly pay for themselves by minimizing hose failures, eliminating costly line failures, fluid loss and downtime. Chiksan swivel joints have a wide range of pressure and temperature ratings to meet most industrial applications. There is a nearby experienced representative who will call, analyze your requirement and make specific recommendations. Write today for his name.



#61-64

fmc **CHIKSAN** COMPANY • 330 NORTH BREA BLVD., BREA, CALIFORNIA

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

Please send me a copy of your catalog and the name of your nearest representative.

Name_____ Company_____

Title_____ Address_____

City_____ Zone_____ State_____

CHIKSAN COMPANY—General Offices: Brea, California • Well Equipment Mfg. Corp. Division (Weco Unions, Homer Valves) • Chiksan International • Chiksan of Canada Ltd. Offices and Representatives in Principal Cities of the World

Let an (Æ) Hydraulic Specialist show you how to get

DEPENDABLE FLUID POWER with (Æ) Hele-Shaw Hydraulic Pumps

Formerly manufactured by The American Engineering Co.

■ **INFINITELY VARIABLE DISPLACEMENT**

■ **INSTANT FLOW REVERSAL**

■ **MAXIMUM HORSEPOWER ECONOMY**

AE Hele-Shaw Pump dependability has been proven by trouble-free service . . . on job after job . . . year after year.

Use the combined experience of AE Hydraulic field specialists and AE Hydraulic Engineers to get a "job-engineered" system to provide AE dependable fluid power for your simple or complex needs.

Call the AE Hydraulic specialist in your area. Representatives in all principal cities.

AE INDUSTRIAL DIVISION (Æ)

AIRCRAFT ARMAMENTS, INC.

Post Office Box 6853, Baltimore 4, Maryland

CLEVELAND DISTRICT: A. E. Company, 1157 Leader Bldg., Cleveland 14, Ohio

N. Y. DISTRICT: AE Industrial Division, 1 Exchange Place, Jersey City 2, N. J.

Circle **159** on Reader Service Card

NEW LITERATURE

Navy size for filters and purifiers in woven bag, paper, or steel shell cartridges. Included are dimensions and specifications on industrial cartridges with pleated, resin-impregnated, filter paper media. Metal end caps and perforated metal enclosures. The 2¾" dia cartridges are made in 3" to 10" lengths, and 6" dia cartridges are made in standard lengths of 6", 9", 12", & 18". *Wallace Filters, Inc., Lebanon, Ind.*

Circle **417** on Reader Service Card

300-VOLT RELAYS

Smaller than conventional 600-volt relays they reduce panel space. Self-contained wiring trough saves space between relay rows. Full-front accessibility with plenty of room for wiring during installation or circuit modification. Improved contact fidelity. Building-block construction for flexible circuitry. Full 10-amp, 300-volt rating. Converts from normally-open to normally closed. All terminals located in the front. Bulletin GEA, 7329. *General Electric Co., Schenectady.*

Circle **418** on Reader Service Card

FLOW SWITCH

A broadly adjustable, flow rate detection unit of extreme sensitivity and dependability, for use in any small tubing or piping system. A pressure differential of ½ psi—liquids or gases—displaces a permanent-magnet-equipped piston which actuates a hermetically sealed switch. The switch contacts operate a remote warning light or other device for a positive indication. Suitable for filter systems as a detecting by-pass or differential relief valve to indicate by-passing caused by clogging.—(FS-10798) *The Gems Co., Farmington, Connecticut.*

Circle **419** on Reader Service Card

DIFFERENTIAL PRESSURE GAUGE

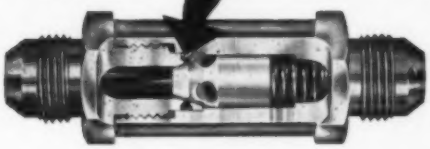
A new differential pressure gauge is described in Bulletin E10, containing specifications, drawings and ordering information. Used for measuring pressure drops across fil-

Circle **84** on Reader Service Card

Kep-O-seal®

RUGGED! DEPENDABLE! CHECK VALVES with the

*Flexible Seal Seat**



- LEAK TIGHT! BUBBLE TIGHT!
- SURGE PROTECTED!
- FLOW—STRAIGHT THROUGH!
- LONG LIFE! EASY CLEANING!
- SIMPLE AND TROUBLE FREE!

The sturdy Kep-O-seal check valve can really take hard service. Conservatively rated, it absorbs severe shock from either direction and always holds its seal. *REMAINS LEAK TIGHT!* Has been proved outstanding in everything from machine tools to missiles! Investigate and see for yourself! Write for full details.

*Patent Applied For

KEPNER

KEPNER PRODUCTS COMPANY
7321 West 59th Street • Summit, Illinois

NEW HEAVY DUTY 7/8" BORE MINIATURE CYLINDERS

Double Acting and Spring Return

Maximum Pressure 250 psi AIR — 2500 psi HYDRAULIC, NON-SHOCK

• Now, a rugged, extra powerful miniature cylinder with all the features desired by designers! Ideal for automation equipment, jigs and fixtures where extra speed and stamina is called for and savings in space, air and cost are necessary. COMPACT: space-saving screw-together construction. INTERNAL CUSHIONS: of resilient Buna-N reduce shock and noise 80%. MOUNTS: Clevis rear, stud front or rear, or foot. ALL PARTS & SEALS: replaceable. PORTS: standard ⅛" NPT on side. TUBES: brass. RODS: high carbon steel, hard chrome plated. SHAFT BUSHINGS: Sintered bronze.
Six STANDARD STROKES available.

Clippard Minimatics

Write for NEW BULLETIN NO. 161

***Clippard* INSTRUMENT LABORATORY, INC.**
7386 Colerain Rd., Cincinnati 39, O. • Phone: JAckson 1-4261
Manufacturers of Miniature Pneumatic Devices, R.F. Coils, Electronic Equipment

Circle **29** on Reader Service Card

AIR-MAZE

Two Stage Compressed Air Line Filters

OVER 99.9% EFFICIENT

DOWN TO SUB-MICRON SIZE!

If your plant uses medium to large compressed air lines, you need Air-Maze Model PL Two Stage Compressed Air Filter-Separators. Exclusive two stage element construction affords over 99.9% efficiency in removing solid particles down to sub-micron size, as well as entrained liquids in the form of fine water mist and oil smoke. Collected liquids drain into the container for easy removal. Because of its large capacity it needs only occasional servicing which can be completed in minutes.

Air-Maze PL Series Filter-Separators withstand operating pressure of 150 psi., are available in a variety of sizes to fit standard pipe inlet and outlet.

FREE! Write for Bulletin No. 777 for additional information.

AIR-MAZE DIVISION
CLEVELAND 28, OHIO

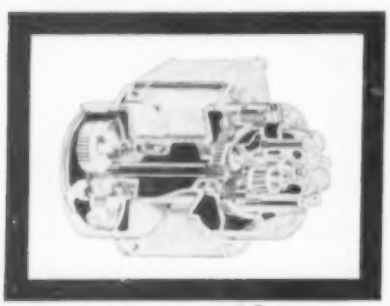
ROCKWELL-STANDARD CORPORATION

Circle **4** on Reader Service Card

GEARMATIC
HYDRAULIC WINCHES

- Fully-hydraulic proven design
- Line pull capacities 6000-22,000 lbs.
- Simple, single-valve control
- Automatic pressure-actuated brake

Gearmatic's sensational new hydraulic winches . . . models 6, 11 and 22 . . . reverse at 0 to 5.25 times forward speed, unloaded or under load. Automatic reversing is also available. Write for Bulletin H-860.



gearmatic
COMPANY LTD.
7400-132 Street, North Surrey, B.C., Canada
GHCD-61

Circle **54** on Reader Service Card

NEW LITERATURE

ters, heat exchangers, gas adsorbers and similar equipment. May be used in all systems rated to 3000 psi. Calibrated 0 to 60 psid. No mechanical linkage between the pressure sensing mechanism and the pointer. No moving seals.—*Pall Corp., Glen Cove, New York.*

Circle **420** on Reader Service Card

GASKET MATERIALS

Detailed information for selection of gasket material presented in separate sections on gasket material and correct design. Includes concentration, purity, and temperature of the corrosive agent; location and construction of gasket material; temperature and nature of fluid or gas contained. Also covered: gasket yield stress "Y" factor, gasket "M" factor, bolt load formulas. Extensive charts.—*Garlock, Inc., Palmyra, New York.*

Circle **421** on Reader Service Card

INDUSTRIAL LUBRICANTS

A 6-step program to streamline lubrication and cut costs. Discusses characteristics of more than 60 types of industrial lubricants. In excess of 1500 hours required to reach a neutralization number of 1.0 for the three lightest viscosity grades used in hydraulic and circulating systems and in high temperature applications. The heavier grades will have less than 1.5 neutralization number at 1000 hours.—*The Pure Oil Co., Palatine, Illinois.*

Circle **423** on Reader Service Card

CYLINDER-VALVE COMBINATIONS

Bulletin announces several automation units for use wherever precision control of air-powered devices is needed. Adjustable controlled rate of feed. Furnished for controlled-pull, controlled-push, or both. Lubrication is sealed in. Can be packaged with any mounting or valve. In valve sizes ¼", ½", ⅜". —*Lehigh Inc., Easton, Pa.*

Circle **424** on Reader Service Card

▼▼▼

MEMO FROM...

grover piston ring co., inc.
120 NORTH BROADWAY — MILWAUKEE 2, WIS.

TO: *Engineering*

Requirements of hydraulic seals have become more and more rigid as pressures, temperatures and cycle-life demands increase.

The Perraseal piston ring combined with economically controlled cylinder and piston tolerances appears to be the answer in many cases. As you consider your present and contemplated sealing applications you will find the story of Perraseal rings very interesting.

Perraseal is a quality hydraulic piston ring featuring a unique joint design - unique in that it seals equally well in both directions - permitting the use of fewer rings per piston and assuring an unexcelled seal.

Circle the reader card to obtain a brochure on the story of Perraseal; it contains a sample ring and engineering data on specifications, dimensions and tolerances.

Yours for better sealing

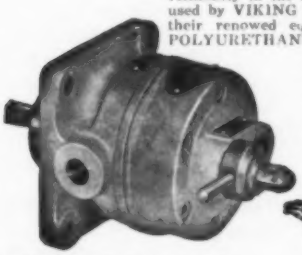
Grover Piston Ring Company, Inc.

Circle **59** on Reader Service Card

Circle **132** on Reader Service Card

INFINITELY VARIABLE DELIVERY

The Savery Variable Delivery Pump gives FLEXIBLE control which is completely POSITIVE over a wide range for use on hydraulically controlled Machinery, Agricultural and Factory lifting gear, Oil Burner equipment and hydraulics for AUTOMATION

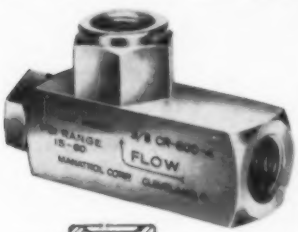


SAVERY PUMPS have a proven record of great reliability in the METERING of chemicals and are used by VIKING ENGINEERING CO., Salford, in their renowned equipment for the production of POLYURETHANE Foams. If you will send full particulars of the properties of any chemicals you wish to pump or meter our Research Department will give you a prompt opinion of the ability of our equipment to handle them.

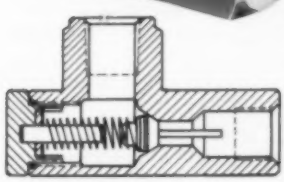
Tests can be carried out on your own materials and a candid and confidential report given with the minimum delay.

Thomas Savery Pumps Ltd.,
Newcomen Works,
Bracebridge Street
Birmingham 6, England
Phone Aston Cross 1316/7

Savery
HYDRAULIC PUMPS



compact positive-action right angle CHECK-RELIEF VALVE



simplifies installation and allows easy access to internal parts without removal from line.

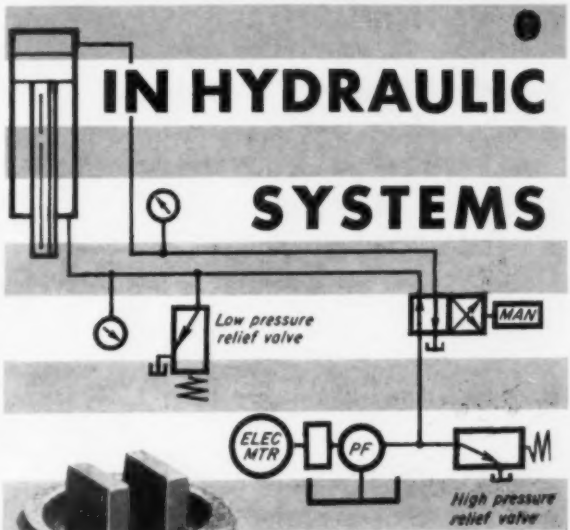
- **internal cracking pressure adjustment is completely tamper-proof.**
- **guided poppet with non-extrudable seal insures quiet, chatter-proof action and a positive shut-off.**
- **excellent re-seating characteristics.**
- **minimum pressure drop prevents loss of fluid power.**
- **valve conforms to J.I.C. Standards.**

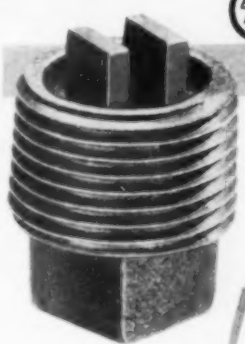
- for use with air, oil, gas, water, other fluids.
- operating pressure ranges up to 5000 psi.
- cracking pressure ranges from 5 to 150 psi.
- standard sizes: ¼, ⅜, ½, ¾, 1, 1¼.
- dry seal female pipe threads.

Write today for complete details.
THE MANATROL Corp.
2372 W. 7th St. • Cleveland 13, O. • CH 1-0575

Circle **93** on Reader Service Card

BETTER PERFORMANCE IN HYDRAULIC SYSTEMS





with

LISLE *Magnetic* PLUGS

Numerous tests and user reports prove that Lisle Magnetic Plugs increase the trouble-free service life of hydraulic pumps better than 300%.

Installed in the flow path or sump, the Lisle Magnetic Plug picks up ferrous metal particles circulating in the fluid — preventing unnecessary wear on critical moving parts and eliminating a major cause of fouled valves.

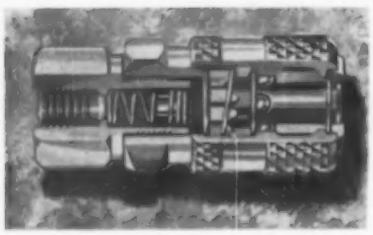
LISLE CORPORATION
CLARINDA IOWA

Write for Catalog and Test Samples.

Circle **89** on Reader Service Card

H-52 QUIK-DISCONNECT KOUPLERS

- NO TWIST
- NO TURN
- NO (secret) COMBINATION
- NO INSTRUCTION



H-52 Quik-Kouplers provide the most positive quick acting, positive shut-off coupling available. Catalogue #52 describes in detail the 150 different sizes and combinations up to 1" pipe thread. Nickel and chrome reusable fittings, adapters, etc. Also described in catalogue #59 is the well known Green Type H-52 Vinyl Plastic Hose. H-52 Quik-Kouplers and Vinyl Hose are stocked and distributed in nearly every major city.

OPERATES QUICKLY
OPERATES SIMPLY
ABSOLUTELY SAFE
INEXPENSIVE*
NICKEL & CHROMED
STAINLESS STEEL
BALLS & SPRINGS

Still $1.30 Each*

* ¼" & ¾" Male & Female

HOFMANN ENGINEERING COMPANY
8694 West 47th Lyons (Chicago Suburb) Ill.
Bishop 2-2222

Circle 69 on Reader Service Card

POST SCRIPTS OF INDUSTRY

News about people, manufacturers and sales organizations

Purolator appoints industrial managers

Porzenheim

The appointment of Thomas E. Morton as administrative manager and Christian J. Porzenheim as sales manager for the new Industrial Sales Div. of Purolator Products Inc. has been announced.

Mr. Porzenheim will direct industrial sales of all field personnel and manufacturer's representatives as well as distribution.

Mr. Morton will have all administrative functions of the new division as well as contributing to the expansion and development for markets.

Baker is Director of Engineering at Wilkerson

Baker

Mr. R. C. Baker has been appointed Director of Engineering at Wilkerson Corp., Englewood, Col., a manufacturer of compressed air filters, regulators, and lubricators. For 9 years Baker was with Sheffield Corp. of Dayton, Ohio. He left there as pneumatic research supervisor to take the new position with Wilkerson.

Ellis opens new quarters

Opening of new quarters for Ellis Fluid Dynamics Corp. has been announced by John T. Ellis, president. Plant and offices are at 7344 Monticello Ave., Skokie, Ill. The newly organized firm will specialize in equipment for control of vibration and shock, offering a full line of standard shock absorbers with a wide range of applications. The company will also design or build custom units.

Waterfield appointed general sales manager

Waterfield

The Page Belting Co. of Concord, N. H., has announced the appointment of Raymond A. Waterfield to the post of general sales manager for their complete line of industrial products. Waterfield came to Page in 1954 as manager of their packings division. His first position in the leather business was with Graton & Knight in 1930. In 1949 he transferred to International Packings Corp.; from here he joined Page.

Fauver appoints Claspill as district sales engineer

Claspill

The J. N. Fauver Co. (distributors, engineers, and contractors of hydraulic, pneumatic, and lube systems equipment) has announced the appointment of Charles B. Claspill, Jr. as District Sales Engineer for their Toledo office serving the northwest Ohio territory. Claspill is a registered professional engineer with eight years industrial design and twelve years industrial sales experience.

Circle **144** on Reader Service Card

Saves hours in piping installations

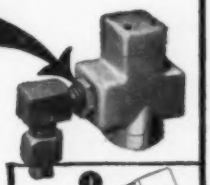
PAT. PENDING

Eliminates leaks in oil, air, water, vacuum, chemical lines

Tru-Seal saves hours in assembling piping installations because it enables you to run your pipe lines in any direction you wish, quickly and easily—without having to recut and re-thread piping sections. Wherever used on air, oil, water, steam, vacuum or chemical lines, it seals perfectly at —100° F. to plus 500° F.—*without the use of pipe dope.* Its installation requires only light tightening torque, thus eliminating over-tightening damage to valves, pumps, compressors, and other fittings.

For further information write

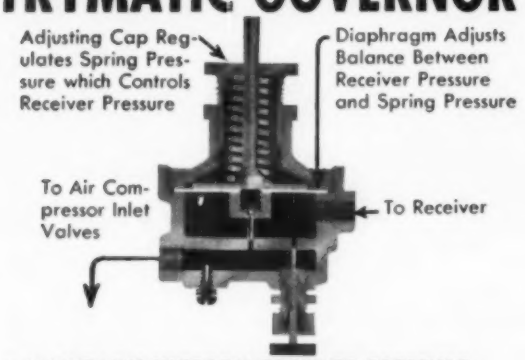
TRU-SEAL DIVISION
FLICK-REEDY CORPORATION
7N017 York Rd., Bensenville, Ill.
"Miller Fluid Power" is also a Div. of Flick-Reedy Corp.



1. Thread Tru-Seal on pipe or fitting as far as it will go hand tight. SEAL SIDE
2. Thread pipe or fitting 3 threads into port. Point in desired direction.
3. Tighten Tru-Seal to complete leakproof assembly (only light torque required).

NEW FOR AIR COMPRESSORS

TRYMATIC GOVERNOR


Adjusting Cap Regulates Spring Pressure which Controls Receiver Pressure
Diaphragm Adjusts Balance Between Receiver Pressure and Spring Pressure
To Air Compressor Inlet Valves
To Receiver

- **MAINTAINS UNIFORM RECEIVER PRESSURE**
- **BOOSTS COMPRESSOR OUTPUT UP TO 10%**
- **CUTS OPERATING AND MAINTENANCE COSTS**
- **FIELD TESTED • FITS ALL COMPRESSORS WITH UNLOADING INLET VALVES**

With the Trymatic Governor, air compressors can deliver uniform receiver pressure (within one pound of any given setting) at all times. Volumetric efficiency can increase by as much as 10%. It will cut operating and maintenance costs. Has only one self-actuating moving part and requires no maintenance! Write for Bulletin , Dept. HP.

TRYMAC, Inc.
16 WEST 5th ST.
ERIE, PA.

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- **No sliding metal-to-metal contact**
- **May be used *With* or *Without* Lubrication**
- **Dead Seal Closing**
- **Full internal porting on all sizes**

Humphrey makes the Simplest Piloted Valve in the World

No. 125A ⅛" pilot-operated "Quick-Dump"

No. 500A ½" pilot-operated "Quick-Dump"

No. 250-4A ¼" 4-way piloted "Quick-Dump"

This is a full ¼" Humphrey "Quick-Dump" piloted air valve delivering 80.04 cfm at 100 psi.

Humphrey has shrunk the valve size and simplified the inside, thereby improving valve performance, lengthening service life, and making installation easier.

Short stroke (.063") plus fast response and built-in quick exhaust give cycling speeds up to 10 cps. Positive dead-seal closing—may be used for valving vacuum down to 5 microns, with air pilot. (Specify vacuum when ordering.) Complete separation of piloting medium from medium being valved.

No lubrication is required. You save cost of oilers, simplify piping, and get oil-free air. (Over-lubrication does not affect the valve.)

Mail coupon today for literature and prices on the Humphrey "Quick-Dump" line.

HUMPHREY PRODUCTS DIVISION
General Gas Light Company
Box 2008 Kalamazoo, Mich.

HUMPHREY *"Quick-Dump"* VALVES

Mail this Coupon for Literature and Prices on Humphrey Piloted — Manual — Cam-operated — Electric Valves

Humphrey Products Div.
General Gas Light Co.
Box 2008, Kalamazoo, Mich.

Please send literature and prices on "Quick-Dump" Valves. We are particularly interested in _____ *valves.*

Firm Name _____
By _____
Street No. _____
City _____ State _____

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You can't meet today's needs with yesterday's valve!

Here is a needle valve for today's needs . . . the kind of product that only Marsh experience in *both* valve making *and* instrument making could produce . . . the one valve that gives precision throttling at *any* pressure — from a few pounds through 10,000 pounds.

For extra stamina and extra safety its body and stem guide are machined from solid bar stock. For greater precision, stem is accurately machined from hardened stainless steel and has fine, closely fitted threads that provide tighter shut-off; closer and more positive flow regulation. Special "Marpak" one-piece packing is long lasting and does not bind even when valves are used on higher pressures.

Marsh Needle Throttling Valves are made in a full range of sizes and patterns — either with steel bodies and stainless steel stems (type 1900) or in stainless steel throughout (type 1924).

Ask for bulletins

MARSH INSTRUMENT COMPANY,
Division of Colorado Oil & Gas Corporation
Dept. 19, Skokie, Ill.
Marsh Instrument & Valve Co. (Canada) Ltd.,
8407 103rd St., Edmonton, Alberta
Houston Branch Plant, 1121 Rothwell St.,
Secl. 15, Houston, Texas
Eastern Seaboard Warehouse:
Marsh Instrument Company,
1209 Anderson Ave., Fort Lee, N.J.

MARSH *Needle Valves*

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POST SCRIPTS OF INDUSTRY

Parker Seal names representatives

J. P. Gregor has been appointed as representative for Parker Seal Co., Culver City, Calif., for the southern Texas, Louisiana, Arkansas, Mississippi, and western Tennessee areas. Earl Hobein has been named representative for the firm in the San Diego, Calif., and Arizona areas.

Formrite completes 5th addition to plant

Completion of a $50,000 manufacturing addition to Formrite Tube Co. plant at Two Rivers, Wis., was announced by J. J. Birkenstock, president. The company specializes in design and fabrication of precision formed metal tubes, fittings, and hose and tube assemblies for fluid transfer lines.

Chaltry named chief engineer

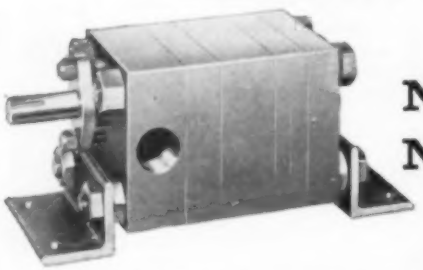
Milwaukee Cylinder Co., Div. of L.&M. Machine Co., has announced the appointment of Richard L. Chaltry as chief engineer. Prior to joining Milwaukee Cylinder he was associated for five years with Dynex Inc. as project engineer on design and development of hydraulic equipment.

Coleman assigned by Wellman Engineering

Coleman

Harold J. Coleman is newly assigned to the northern Ohio district (including Akron) for the Wellman Engineering Co's Anker-Holth Div., maker of power cylinders. Coleman will represent the full product line—production and specially engineered application models. He was formerly with Paquin Co., Cleveland, where he had wide experience in sale of hydraulic and pneumatic equipment.

for pumps as individual as a fingerprint!



SPECIFY NORTHERN NITRALLOY PUMPS

Select a Pump Sized for the Exact Capacity and Pressure of Your Application

39 pump sizes	.24 to 145.6 GPM	50 PSI
38 pump sizes	.24 to 145.2 GPM	100 PSI
31 pump sizes	.23 to 121.0 GPM	200 PSI
27 pump sizes	.22 to 93.1 GPM	300 PSI
27 pump sizes	.22 to 91.5 GPM	400 PSI
19 pump sizes	.21 to 57.8 GPM	600 PSI
15 pump sizes	.19 to 44.7 GPM	800 PSI
14 pump sizes	.17 to 43.5 GPM	1000 PSI
11 pump sizes	.14 to 15.5 GPM	1500 PSI
6 pump sizes	.59 to 14.0 GPM	2000 PSI

Please write today for free catalog and engineering data

Northern Ordnance Incorporated
Subsidiary of NORTHERN PUMP COMPANY
Minneapolis 21, Minnesota

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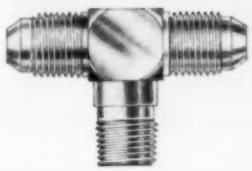
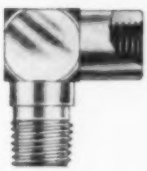
Circle **87** on Reader Service Card

TUBE FITTINGS

L&L 37° flared tube fittings (to SAE & JIC standards) have heat-treated tube ends, and large wrench flats. The most complete line anywhere. All L&L fittings are made of plated steel.



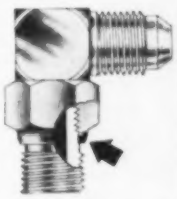
PIPE FITTINGS



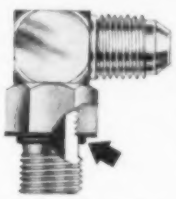
L&L dryseal fittings have annealed threads. Thick walls permit tapping for gauges. JIC.

METAL SEAL

L&L 'CN' fittings *seal*, with any fluid, temperature, pressure, or port metal. Will fit SAE port.



STRAIGHT THREAD TUBE FITTINGS



O-RING SEAL

L&L makes a complete line of standard SAE O-ring seal fittings. JIC.

"SPECIALISTS IN HYDRAULIC FITTINGS"

L and L Manufacturing Company

21590 Hoover Road • Warren, Michigan

DISTRIBUTORS IN PRINCIPAL CITIES

L&L

NEW FILTER

with

FILTER CONDITION INDICATOR*

eliminates need for periodic service

A quick glance at the pressure gage on this new hydraulic line filter tells you when its element needs cleaning or replacement . . . warns of impending pressure build-up *before* the built-in by-pass valve can open and allow circulation of unfiltered fluid . . . makes unnecessary the costly and wasteful procedure of inspecting or changing elements at periodic intervals.

It's a big half-gallon filter, with choice of interchangeable monel wire cloth or phenol treated paper elements. Inlet and outlet ports are full 1¼" NPTF. Pressure drop at flow rate of 60 gpm is only 5 psi when using the 200-square-inch, 100-mesh, wire cloth element.

Filter may be installed in either the suction line (between tank and pump) or the return line (between control valve and tank), and the element is easily accessible.

***Amazing fact:** *The price of this new filter is even lower than many filters without this outstanding feature.*

GRESEN
MANUFACTURING CO.
405 - 36th AVENUE N.E., MINNEAPOLIS 18, MINN.

GRESEN HYDRAULICS

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maintains user preference for . . . YOUR PRODUCT

Palmetto®
PYRAMID®
V-PACKING

Pyramid protects the reputation of your hydraulic or pneumatic equipment with packing that gives long-lived, trouble-free service. Its advanced design remains dependably leak-free at all pressures; its proved construction features stronger walls and hinge area molded of endlessly folded fabric—which cannot fray and clog the hydraulic system. Pyramid rings have uniformly sharp sealing lips.

Curved lips and single lines of contact permit each ring to flex independently in response to pressure changes.

NEW SEALSAVER®
ADAPTER RINGS FOR PYRAMID

Palmetto's "Sealsaver" adapters outperform all other types. They combine the strength of reinforced plastics with the unique ability, under pressure, to close the entire piston or rod clearance and completely eliminate extrusion.

PALMETTO PACKINGS

Write for Details Now

GREENE, TWEED & CO.

OUR 99TH YEAR

NORTH WALES, PA.

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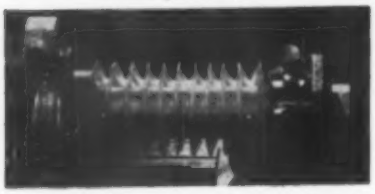
HIGH-FLEX DUST BOOT

made of electronically sealed plastic film



Inexpensive dust boot (bellows) seals hermetically against abrasive chips and dust, or against corrosive liquids; high flexibility often permits installing on existing air or hydraulic cylinders without increasing stroke or space requirements. Also used to protect traverse screws and ball slides. Boot may be transparent to reveal internal conditions.

Boot is recommended for –20° to 220° F and is available in standard sizes from 1" to 6" OD. Also made in custom sizes, colors and shapes, any quantity. **Literature and detailed recommendations sent** (no salesman will come)—write or call **A. F. Gagne Associates, 50 Wall St., Binghamton, N.Y.**

POST SCRIPTS OF INDUSTRY

Cardair moves headquarters

Cardair, Div. of Marmon-Herrington Co. Inc., has moved its headquarters to Lebanon, Ind. Formerly located in Chicago, the firm is a major manufacturer of central compression systems used to provide ultra high pressure air and other gases for missile component testing and industrial uses.

Garton elected to Greer board

Garton

Rear Admiral N. F. Garton, U.S.N. (Ret.) has been elected a member of the Board of Directors of Greer Hydraulics Inc. Since 1960, Garton has been president and chief executive officer of Vought Camera Co. He has also been associated with Electronics Research Inc., Lockheed Aircraft Co., and Hughes Aircraft Co.

Humphrey Products expands line, names sales manager

Robinson

Leslie E. Robinson has been appointed general sales manager of the Quick Dump valve line made by Humphrey Products Division, General Gas Light Co. He has been director of OEM sales. Extensive planning is being done both for broadening the Quick Dump line and for strengthening Humphrey's sales and service. New model valves will be introduced in new markets with additional distribution.

Rucker appoints three

The Rucker Co. has announced the appointment of three company men to new positions.

Donald A. Anderson was pro-

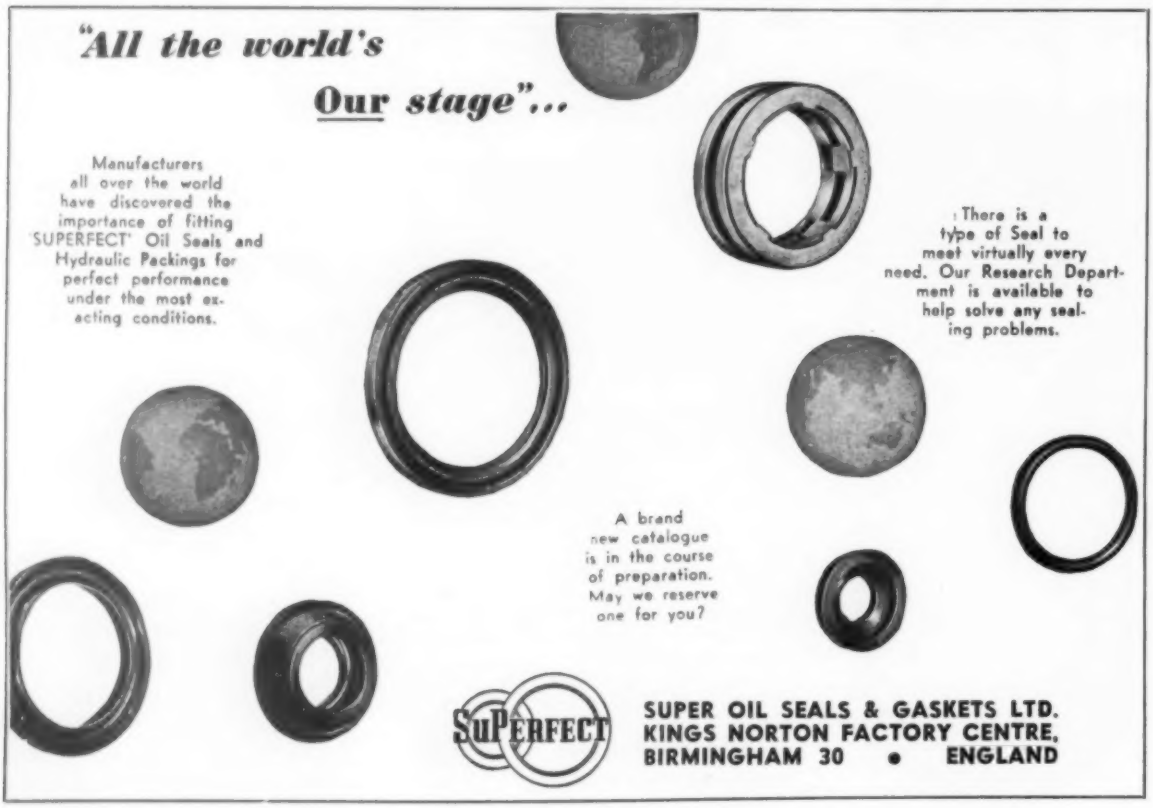
Continued on page 158

"All the world's Our stage"...

Manufacturers all over the world have discovered the importance of fitting 'SUPERFECT' Oil Seals and Hydraulic Packings for perfect performance under the most exacting conditions.

There is a type of Seal to meet virtually every need. Our Research Department is available to help solve any sealing problems.

A brand new catalogue is in the course of preparation. May we reserve one for you?



SUPERFECT

SUPER OIL SEALS & GASKETS LTD.
KINGS NORTON FACTORY CENTRE,
BIRMINGHAM 30 • ENGLAND

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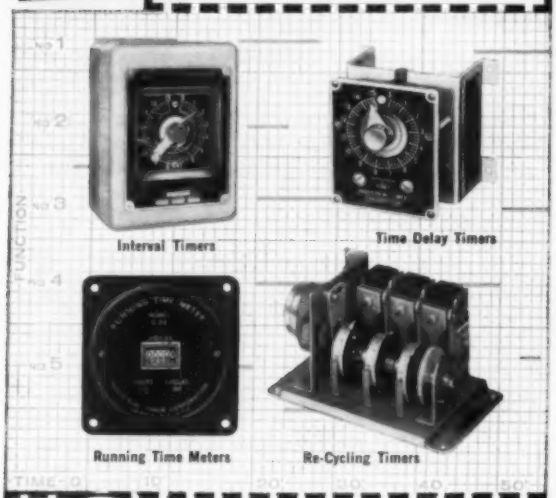
AUTOMATIC TIMERS

A complete line for industrial applications and original equipment



INDUSTRIAL TIMER CORPORATION
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Canada: Sperry Gyroscope Ottawa Ltd.
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HYDRAULIC VALVES AND PUMPS..

to YOUR specifications

Over twenty years of specialized hydraulic valve and pump experience — newly enlarged, modernly equipped manufacturing facilities — an outstanding staff of thoroughly experienced craftsmen and an imposing list of satisfied customers is the best recommendation we can think of that you too will like our work.

Hydraulic valve and pump building is a highly specialized field demanding skills and equipment which many important companies have found too costly to maintain in their own plants. We are doing their work today.

Why not invest a few minutes to hear the advantages of our service. It might well save you money and headaches.

HYDRAULIC ACCESSORIES CO.
24301 Hoover Road, Warren (Detroit) Mich.

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Just Out! Just the ticket to cut cost!

⅛" — $3.00
¼" — $3.25

ROSS "CUB"

NEW SPEED CONTROL VALVE

⅛" and ¼" pipe sizes in stock now!

Now a speed control valve that regulates your cylinder movement with precision and sureness, but which lists at $3.00 and $3.25. And despite its lower costs, "CUB" features the same high quality of design and workmanship you've come to expect from Ross. "CUB'S" design stresses trouble-free operation and easy maintenance. CUB is small, aluminum and lightweight. If you use speed controls, by all means call your Ross representative or write us.

ROSS OPERATING VALVE CO.
105 E. Golden Gate Ave. • Detroit 3, Michigan

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PUBLICATIONS

HOW TO SELECT QUICK-CONNECT COUPLINGS . . . Nov., 1960

8 pages discussing the design factors which a user should consider in selecting a coupling. Sectional drawings of various designs.

WHAT YOU CAN GET IN ROTARY ACTUATORS . . . Aug., 1960

6 pages showing designs, operating specifications, and application ideas.

PLASTIC LINES—CAN THEY MEET YOUR FLUID POWER NEEDS? . . . Apr., 1960

This report boils down the characteristics of various types of plastic tubing—the 'do's" and "dont's" for successful applications.

WHAT TO LOOK FOR IN AIR VALVES . . . Apr., 1959

16 pages describing and illustrating basic designs of directional, pressure, and flow control valves.

TEMPERATURE CONTROL IN HYDRAULIC SYSTEMS

16-page report on system design, fluids, packings. Components affecting temperature control.

A COURSE IN HYDRAULIC VALVES
PART 1: Directional Controls

Basic characteristics of spool, packed plunger, rotary, poppet, sliding plate valves.

A COURSE IN HYDRAULIC VALVES
Parts 2 & 3: Pressure Controls, Flow Controls

Basic Characteristics of relief, pressure reducing, sequence, counterbalance, unloading valves; compensated and uncompensated flow control valves

ELECTRICAL CONTROLS FOR FLUID POWER SYSTEMS

8 pages of charted specifications for limit switches, timers, solenoids, and pressure switches.

Prices for all above reprints:

1—10 copies—50c ea.
10—24 copies—35c ea.
25—49 copies—25c ea.
50 or more —15c ea.

FLUID POWER HANDBOOK & DIRECTORY

1962/63 Edition 1000 pages $12 ($15 Foreign)

272-page Design Data Section, Product Directory, Trade Name Index, Manufacturers' Catalogs, Directory of Local Distributors.

Revised JIC HYDRAULIC STANDARDS

32 pages of standards adopted April 1959:

1—10 copies—75c ea.
10—24 copies—60c ea.
25—49 copies—50c ea.
50 or more —40c ea.

Out-of-print copies of HYDRAULICS & PNEUMATICS Magazine are available in complete volumes as positive microfilm copies from: University Microfilms, 313 N. First Street, Ann Arbor, Michigan.

Send all orders with exact amount in coin, currency, or check to:

HYDRAULICS & PNEUMATICS
812 Huron Road
Cleveland 15, Ohio

POST SCRIPTS OF INDUSTRY

moted to the position of Assistant to the Vice President. He has been the company's District Manager of the Los Angeles facilities for the past five years.

Anderson

Ayers

Thomas S. Cozzens is now the Southern California District Manager. He has been Sales Manager of the Northern California District since 1955.

James M. Ayers was promoted to Northern California Sales Manager. He joined Rucker in 1955 and has been Special Accounts Manager since 1960.

Friesland appoints director of sales

Friesland Plastics Co. of Friesland, Wis., has announced the appointment of Delbert De Young as Director of Sales. Mr. De Young's appointment coincides with the firm's acquisition of production facilities for their Tape-Seal Teflon tape. Mr. De Young was formerly with the DuPont Co. Technical Service Laboratory, Teflon Product Development, and Field Service Dept.

New distributors

The AE Industrial Div., Aircraft Armaments Inc., Baltimore, has six new representatives: *A. L. Hacker Co.* is covering Maryland; *R. C. Neal Co.* of Buffalo is covering New York state (except N.Y.C.); *Nielsen Hydraulic Equipment* has the metropolitan New York area, lower Connecticut, and northern New Jersey; *Southwestern Controls* has Texas; *Paul-Munroe* will have southern California; and *Hawaiian Fluid Power Corp.* will cover the islands.

Continued on page 160

GRATIS . . . a 12 page HYDRAULIC CIRCUIT and FLUID MANUAL for almost every type and size hydraulic installation.

HERE IS A BIG 8½" x 11", file size 12 page, fully illustrated booklet. It's brimful of technical data and drawings that every designer and operating engineer will want to read and keep for ready reference. Write for your copy. No obligation.

Briggs

HYDRAULIC FLUID AND OIL FILTERS

FILTER/SEPARATORS • AIR AND GAS LINE FILTERS • FILTER CARTRIDGES

THE BRIGGS FILTRATION CO.
DEPT. 396, WASHINGTON 16, D. C.
Send me manual. No Obligation.

Name .....
Company .....
Address .....

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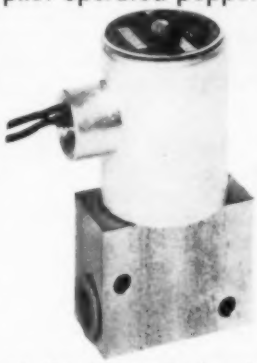
Circle **46** on Reader Service Card

NEW HIGH PRESSURE SOLENOID VALVES

Two-Way Solenoid Valves
for Oil Pressures to 3000 psi

Two types are available: normally open, and normally closed. Both are pilot operated poppet type valves in cartridge form. They can adapt to any type of manifold or subplate. All standard AC or DC solenoids are interchangeable. Only two moving parts—poppet and plunger—make these valves less susceptible to malfunction due to contaminated systems.



All valves have free reverse flow in the de-energized position. Hardened, ground and lapped parts with oil immersed plunger assures long trouble-free operation. Many modifications to specific requirements are possible.

Write for illustrated circular with blueprint.

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new ROTORAM® VALVES

WITH EXCLUSIVE ROTATING STEM

for MILLIONS of TROUBLE-FREE ACTUATIONS

Treadle Valve

Knob Valve

- Low silhouette mounting
- 2024 T4 aluminum bar stock
- Rust-resistant
- Full flow air passages
- Piped exhaust ports
- Interchangeable parts
- Anodized finish

Cam Valve

Finger Valve

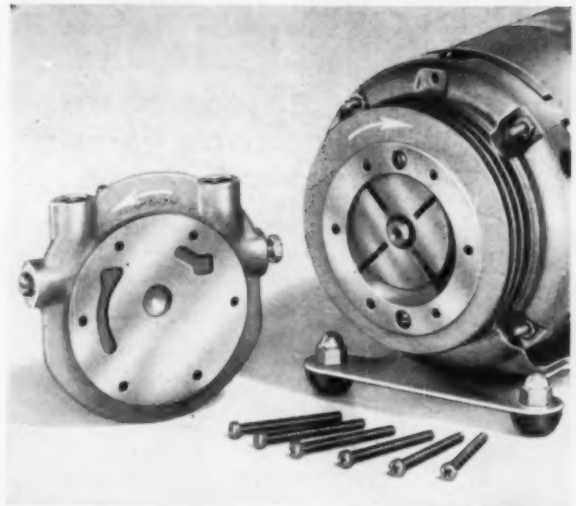
Pedal Valve

Hand Ball Valve

Rotoram Valves are available in 3 and 4-way models for ⅛", ¼", ⅜" and ½" pipe sizes. Special Block "V" Packing permits free ram movement, insures long valve life. Port entry from either left or right side. Ask your AIR-MITE Distributor, or write for complete details and illustrated catalog.

AIR-MITE DEVICES, INC.
4401 W. Kinzie St., Chicago 24, Ill.

Circle **5** on Reader Service Card



NEED AN OIL-FREE AIR SUPPLY?

Select from 3 types, 10 sizes

GAST OIL-LESS* AIR PUMPS

You gain five advantages when you specify Gast Oil-less Air Compressors or Vacuum Pumps.

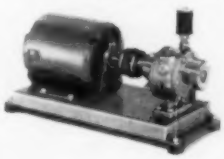
1. Absolutely oil-free air delivery. No hot oil mist or odor can contaminate air flow.
2. No lubrication required. This eliminates problems for both manufacturer and user.
3. Lubrication costs for both time and lubricants are eliminated.
4. You have greater freedom in locating the pump, as easy access for oiling isn't a factor.
5. Oil-less design adds a sales feature to your product!

How is this possible? Rotary design has carbon vanes that lubricate themselves. Ball bearings are grease-sealed for life and located outside the pumping chamber. Simple construction assures long, trouble-free dependability.

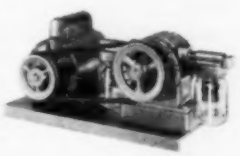
Ten sizes; capacities from .35 up to 24 c.f.m. running open. For medium duty to 10 p.s.i.g. pressure or 20" Hg vacuum. For use on instruments, medical and laboratory equipment, food packaging and paper-handling machines, Gast Oil-less Air Pumps have much to offer.

Miniature models, .35 to 1 c.f.m.

Direct coupling drive, to 5.9 c.f.m.



Integral-motor types to 1.1 c.f.m.



V-belt drives, up to 24 c.f.m.

*A wide range of lubricated models also available.

WRITE TODAY FOR OIL-LESS BULLETINS —
if possible, specify c.f.m. range that interests you.

Air Motors • Vacuum Pumps • Compressors

GAST MANUFACTURING CORP.
P.O. BOX 117-D, BENTON HARBOR, MICH.

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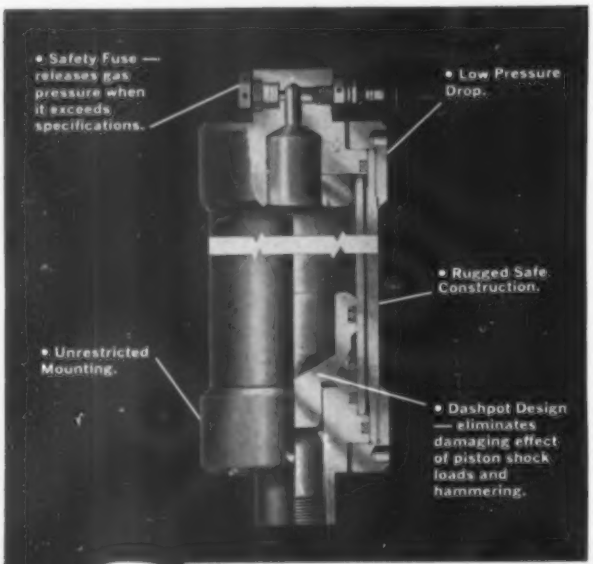
SUPERIOR

In Design, Performance And Maintenance-Free Service


• Safety Fuse — releases gas pressure when it exceeds specifications.
• Low Pressure Drop.
• Rugged Safe Construction.
• Unrestricted Mounting.
• Dashpot Design — eliminates damaging effect of piston shock loads and hammering.

Superior

Piston Type ACCUMULATORS

...a wide range of dependable double shell and single shell A.S.M.E. approved models are now available for any industrial or military application.

The Superior accumulators are the product of over ten years of design, development and manufacturing experience.

Proven in critical installations, the Superior accumulators incorporate the most ideal combination of design and performance characteristics ever offered. The design features a permanent piston for long-life, trouble-free service — no diaphragm or bladder to replace.

Write for NEW 1961, FREE catalog.

Inquiries from Qualified Distributors Invited.

Superior

Hydraulic Division

15201 St. Clair Ave. • Cleveland 10, Ohio

Division of Superior Pipe Specialties Co.

2917 S. Cicero Ave. • Cicero 50, Illinois

MEMBER OF NFPA

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POST SCRIPTS OF INDUSTRY

The appointment of *Web Packing Co.*, Webster, N. Y., as a distributor for Parker Seal Co. was announced by T. J. McCuistion, vice president of sales. Web will cover New York State, and will handle the Parker O-ring line.

Hydraulic & Air Equipment Co., Portland, Oregon, has been selected to represent Denison Engineering Div., American Brake Shoe Co. The company will cover the states of Washington, Oregon, Idaho, Montana, and Wyoming.

Three new distributors for L & L Mfg. Co., Detroit: *Fred M. Hogle Ltd.* of Montreal and Toronto to handle eastern Canada; and *F & S Distributors*, Clifton, N. J. to cover New Jersey, eastern New York—including metropolitan New York and Long Island. *Industrial Air Controls Inc.*, Fort Worth, Tex., will distribute the line in northeastern Texas.

Parker Seal Co., Culver City, Calif., has appointed *Cal-State Seal Co.*, Garden Grove, Calif., as a distributor. They will handle Orange, Riverside, and San Bernardino Cys. in southern California. *Seals & Engineering Inc.*, Rockford, Ill., has also been appointed a distributor. They will cover Rockford and the surrounding area.

Stewart and Stevenson Distributing Co., Houston, will distribute hydraulic accumulators, valves, and other components in Texas, for Greer Hydraulics, Inc., Los Angeles. *Hydraulic & Air Equipment Co.*, Portland and Seattle, will cover Oregon and Washington; *Power-Mac, Inc.*, San Francisco, Calif.

Hydraquip Corp., Houston, has been named distributor for Ross Operating Valve Co., Detroit, and Tomkins-Johnson Co., Jackson, Mich.

John N. Magaw Co., Lakewood, Ohio, is now a representative for valves manufactured by Beckett Harcum Co. Territory covers northern Ohio.

F & W Ursem Co., Cleveland, has been appointed exclusive stocking distributor in Cleveland and northern Ohio for the Lenz Co., Dayton, Ohio.

Synflex Products Div., Samuel Moore & Co., Mantua, Ohio, has appointed *Lucas Supply Co.*, Newark, Ohio, as its authorized master distributor to stock its complete line.

Hydro-Line Mfg. Co., Rockford, Ill., has two new domestic representatives: *Leo J. Schindler Co. Inc.* will handle the line throughout Texas, and *Edwards Engineering Corp.* will cover Louisiana and southern

Continued on page 162

Circle **13** on Reader Service Card

NEW! Pneu-trol® QUICK EXHAUST VALVE

Fast air dumping AT THE CYLINDER permits use of smaller valves and piping . . . INCREASES EFFICIENCY AND SPEEDS

Operating Pressures: 1 to 125 PSI For ⅜" and ¼" pipe sizes

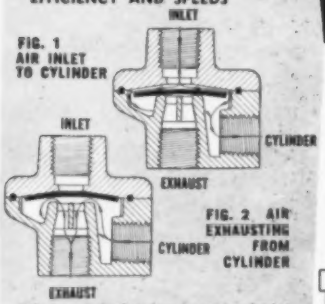
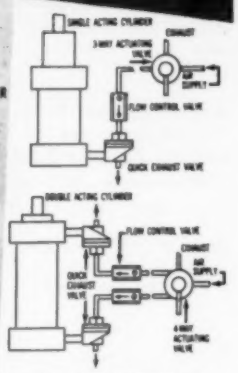


FIG. 1 AIR INLET TO CYLINDER

FIG. 2 AIR EXHAUSTING FROM CYLINDER

When control valve is opened air pressure seals exhaust port and diaphragm is deflected permitting air to pass thru the cylinder port (Fig. 1). When inlet pressure is relieved (by actuating valve in control circuit) the buildup of cylinder return pressure closes inlet port (Fig. 2) snapping the diaphragm off the exhaust port allowing instantaneous evacuation of exhaust air. *Write for complete details, specifications and prices.*



TYPICAL APPLICATIONS of Quick Exhaust Valves in Single and Double Acting Cylinders. Because exhaust air is dumped at cylinder, smaller diameter piping and smaller selector valves can be used

AUTOMATION AUTO-PONENTS INC COMPONENTS

AUTO-PONENTS INC.
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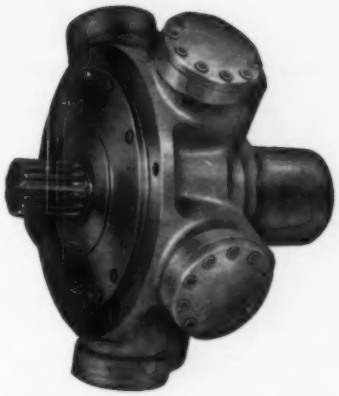
HIGH TORQUE VARIABLE SPEED (1-100 r.p.m.) HYDRAULIC MOTORS



Mark IV—5 cylinder 4,500 lbs. ft. at 2,000 p.s.i. (Speed 1—100 R.P.M. reversible). Overall efficiency 90%—95%.
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Leytonstone 3678
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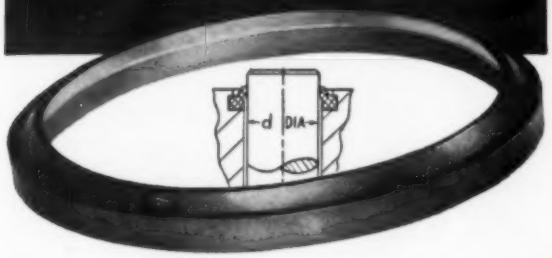
NOW-a "snap-in" rod wiper that really works!



This new, *non-metallic rod wiper* is made in *one piece* of Disogrin's polyurethane elastomer. It offers the outstanding resilience, "memory", abrasion and tear resistance proved in Disogrin "U" cups and "O" rings and in fork truck wheels. It is not affected by ozone and scrapes absolutely everything from the rod without scratching or marring.

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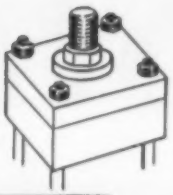

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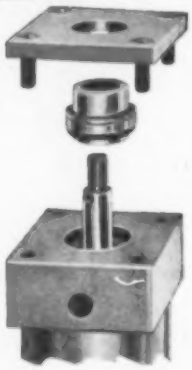

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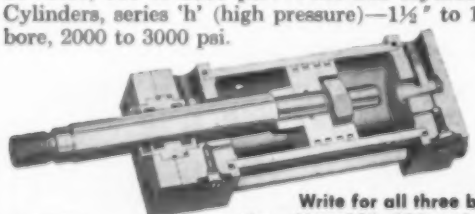

Write for all three bulletins—Nos. 202, 203 and 204—describing Mo-Bar Air and Hydraulic Cylinders for fluid power applications . . . Dept. B

MO-BAR
HYDRAULICS CO.
Crystal Lake, Illinois

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POST SCRIPTS OF INDUSTRY

Mississippi. *Press Automation Systems Inc.*, Oxford, England, has been appointed representative for Great Britain and Northern Ireland.

Synflex Products Div., Samuel Moore & Co., Mantua, Ohio, has appointed the following as authorized master distributors: *N. L. Kuehn Co.*, Milwaukee; and *Syracuse Supply Co.*, Syracuse.

A. E. Borden Co. Inc., Boston, has been appointed as a dealer of fluid power products manufactured by Arrow Tools Inc., Chicago.

Rivett Lathe & Grinder Inc., Boston, Mass., has appointed *Hydro Air Inc.*, Scotch Plains, N. J., as exclusive distributor in New York City, Connecticut, and northern New Jersey. Offices are in Scotch Plains; Brooklyn, N. Y.; and Hamden, N. J.

Lincoln Supply Co. has been named exclusive New England distributor for Hoffman Valves. Lincoln has offices in Pawtucket, R. I.; and Boston, Worcester, and Springfield, Mass. ▼▼▼

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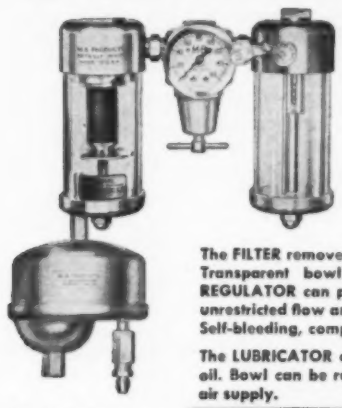

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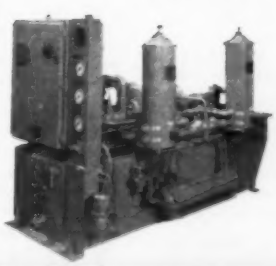

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VALVES

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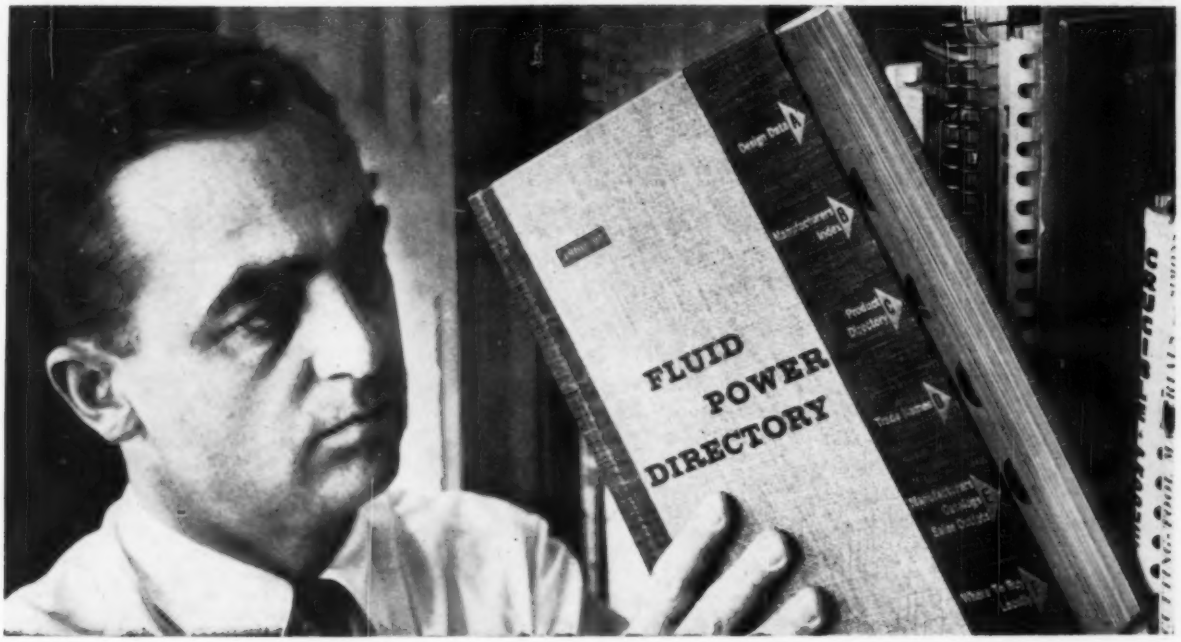

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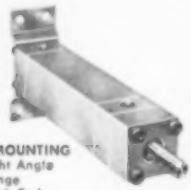

C MOUNTING
Right Angle
Flange
Blank End

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NO TIE RODS! NO LOCK RINGS! All components including Mounting Attachments neatly contained by only four (4) bolts at each end.

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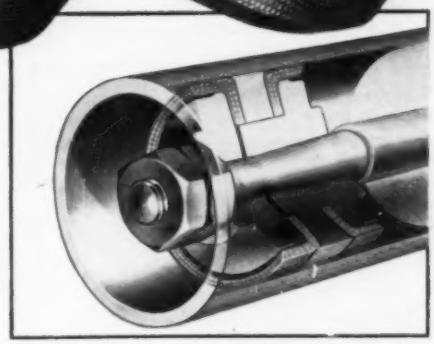

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TRADE MARK PUMCUPS

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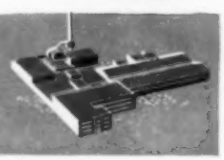

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